# Typical Problems Leading to Delays, Cost Overruns, and Claims on Process Plant and Offshore Oil and Gas Projects

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## List of Typical Problems

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*(continued)*

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OVERVIEW

Owners and contractors face enormous challenges to complete billion dollar engineering and construction projects for process plant and offshore oil & gas facilities. The problems that often occur can lead to significant delays, cost overruns, and claims. These typical problems include, but are not limited to, the following:

1. Insufficiently defined FEED;
2. Inadequate design basis for production rates and properties;
3. Inaccurate contractor cost estimates;
4. Ambiguity of the contract documents;
5. Inadequate documentation;
6. Multiple change orders;
7. Insufficient management of contractor design and construction interfaces;
8. Insufficient and inexperienced owner technical personnel;
9. Inadequate baseline schedule development and updating by contractors;
10. Insufficient and unreliable integrated Master Project Schedule;
11. Insufficiently sized camp facilities for housing the onsite construction and startup work force on remotely located projects, leading to delays and large cost increases for additional camp construction or hostels;
12. For offshore oil & gas projects, incomplete onshore fabrication prior to shipping leading to large amounts of carryover work offshore; and
13. Failure by owners to have a sufficient and experienced management team in place to manage change orders, requests for time extensions, and claims.

This article describes these problems and presents recommendations to minimize the potential that they will occur, and if they do, mitigate the impacts of these problems.

# Typical Problems Leading to Delays, Cost Overruns, and Claims on Process Plant and Offshore Oil & Gas Projects

PROBLEM

**1. Insufficiently defined FEED, causing change orders, delays, and cost overruns.**

As one of the stage-gate steps in the development of a project, the owner typically contracts with an engineering contractor to prepare a Front End Engineering Design (FEED) package to further the development of its conceptual design that was previously prepared during an earlier stage of the project development cycle. For process plant projects such as refineries, chemical and petrochemical plant projects, oil & gas facilities, gas plants, and LNG projects, the FEED Package will typically include a process description and design basis description, input and product production and consumption rates, an optimized heat and mass balance, process flow diagrams (PFDs), partially developed piping & instrumentation diagrams (P&IDs), equipment process datasheets and specifications, instrument datasheets and specifications, equipment list, line list, utility flow distribution drawings, preliminary plot layout, environmental design requirements, and perhaps other basic design information.

The FEED package design information is not a final design and, therefore, is not sufficient to procure all equipment and materials and construct the project. However, if the design requirements are properly defined, an experienced engineering and construction contractor can use the FEED package to develop a lump sum bid for the engineering, procurement, and construction (EPC) phase of the project. To do that, the EPC contractor, during the bid phase, must further develop the design such that it can estimate quantities, equipment, materials, and other requirements for the project, adding appropriate contingencies for design development.

Because the FEED package is not a completely developed design package with final drawings and quantity takeoffs sufficient to procure equipment and materials and define the construction packages, the EPC contractor may underestimate its bid costs and the time required to perform the work. If the owner selects the lowest bid, that EPC contractor may eventually learn that it either left out scope, did not provide sufficient contingencies in its quantity estimates, or find that the design has to be modified to a greater degree than it planned so that it can comply with the detailed specifications that are required for the project.

The EPC contractor then submits numerous change orders to attempt to recover for these problems, leading to delays in completion of the project and increased costs. Owners often consider that many of these design problems are not compensable because they believe that the EPC contractor's scope is to further develop the design, and thus the modifications that the EPC contractor makes to the design documents are the result of this design development. However, the EPC contractor may view differences between the preliminary drawings and other design documents, and the equipment, instrumentation, and other specifications in the FEED as design conflicts or inaccuracies for which the owner is responsible and which will require increased costs and time to resolve. Thus, owners are faced with the dilemma of either resolving the FEED package design

issues that are identified during the EPC phase by agreeing to change orders that include additional costs and time extensions, or face large delay and disruption claims at the end of the project.

**RECOMMENDATION**: The owner should conduct a cold eyes review of the bid package and FEED documents that it intends to submit for obtaining lump sum bids for the EPC phase to ensure that the FEED package and detailed design requirements are well-defined, the requirements are clearly stated and unambiguous, and the contract documents and project procedures are properly drafted for a lump sum contract. Also, owners should consider including in the EPC Phase a 30 to 60-day period for the successful EPC bidder to further review the FEED package and requirements in detail and advise the owner of any discovered problems such that these problems can be resolved before too much time is lost. Owners may also consider including in the EPC contract a provision to consider change orders to resolve design conflicts or ambiguities during this initial 30 to 60-day period. The contract should also contain an order of precedence provision that states which documents control the detailed design requirements should conflicts and ambiguities exist in the FEED package documents.

PROBLEM

**2. Inadequate design basis for oil, gas, chemical, and petrochemical production rates and properties, leading to design changes which delay the project and increase its costs.**

Owners often attempt to improve the timing of project delivery by identifying the design basis of the FEED work using preliminary oil, gas, chemical, and petrochemical properties, compositions, and flow rates. The thinking is that the completed FEED package can be updated with the updated design information, and the detailed design contractor can update the design with the final feed and product properties, compositions, and flow rates. The problem is that the EPC contractor submitted its bid price and schedule based on the FEED package and its design basis. If the final feed and product properties, compositions, and flow rates are sufficiently different from the FEED design basis, the EPC contractor will submit change orders with delays and cost increases to resolve those differences.

**RECOMMENDATION**: If the owner learns that the oil and gas properties, compositions, and flow rates are sufficiently different from the FEED design basis, it should consider delaying the issue of its bid documents to the EPC contract bidders and go back to the FEED engineering contractor and update the FEED package with the new information. That will be a less costly solution compared to making those changes under a lump sum EPC contract. It may also reduce the overall time to complete the EPC project.

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PROBLEM

**3. Inaccurate cost estimates by the contractor due to inadequate FEED definition resulting in huge cost overruns when scope definition becomes better defined.**

In an effort to initiate the EPC phase of a project as quickly as possible, owners may prematurely send out their FEED packages to engineering and construction contractors seeking lump sum bids. Unfortunately, consequences of such decisions can be one or more of the following:

- Highly qualified EPC firms will decline to bid, leaving the owner without confidence that its project can successfully proceed;
- Highly qualified EPC firms will submit bids, but will include large contingencies which may make the project uneconomical;
- Highly qualified EPC firms will recommend that the owner convert its contract basis from lump sum to reimbursable in an effort to reduce the EPC contractor's risk but provide the owner with reduced confidence as to the true capital cost of the project; and
- Lower-tier contractors who are eager to enter a new market will submit lump sum bids. If they are successful, problems with the FEED documents will eventually be identified and large change orders, cost overruns, and delays will result during the execution of the project. If the owner refuses to accept the requested change orders, the contractor may default rather than risk financial ruin.

**RECOMMENDATION:** The owner has few good options until it prepares a FEED package with sufficient definition that will enable the EPC contractor to understand the full scope of the project. The plot plan for the process units needs to be well planned. Process flow diagrams, P&IDs, and equipment specifications need to be taken to a level of completeness that will enable the EPC contractor to obtain competitive bids for equipment, understand the civil earth-moving requirements, and quantify concrete, structural steel, piping, electrical, and instrumentation material requirements without significant contingencies. Experienced EPC contractors understand that some level of design development occurs when a FEED package is developed into "Issued for Construction" drawings and specifications. Design development is part of the EPC contractor's scope of work and the cost of this engineering should be included in the bid price. While some level of scope changes typically will occur even with a well-developed FEED package, if the amount of changes exceeds six to eight percent, then the owner may be exposed to a cumulative impact claim at the end of the project.

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PROBLEM

**4. Ambiguity of the contract documents, leading to disputes over procedures for progress measurement and reporting, technical specification requirements, cost and schedule control, and change order management.**

Contract documents and cost, schedule, change management, and progress reporting procedures are often taken from previous projects, dusted off by a new project team, and assembled for use on the next project. It is unlikely that all requirements from a previous project will be appropriate for the next project, and the boilerplate needs careful review to ensure that the contractual and technical specification requirements are correct and that the progress measurement and reporting, cost and schedule control, and change order procedures are coordinated and appropriate for the type of contract envisioned for the engineering, procurement, and construction phase of the project. For example, a lump sum contractor will be submitting less detailed actual budget and man-hour breakdowns as part of its progress reporting than it would under a cost reimbursable contract. The level of support from the contractor that will be required for pay applications will be different for lump sum contracts than it will for reimbursable contracts. The basis for calculating the progress and percent completion amounts needs to be defined. The owner must also decide what it will do to verify the contractor's progress and percent complete submittals. The contractor's actual labor productivity may not be discernable from the data it submits to the owner under a lump sum contract; therefore, actual man-hours may not correlate well to percent complete. Problems also occur when the bid package does not define the supporting schedule delay calculations and documentation that the contractor is required to submit to justify a time extension.

**RECOMMENDATION**: The owner should have an experienced contract administration/ construction claims expert review its contract procedures to ensure they are appropriate for the type of contract envisioned and are sufficiently detailed and coordinated to obtain information to evaluate the basis for progress, cost and man-hour updates, schedule updates, and productivity measurement.

PROBLEM

**5. Inadequate documentation to support positions and resolve issues that develop during the execution of the project or retrospectively when large claims develop at the end of the project.**

Contractors often attempt to submit minimal information during a project with which an owner can evaluate the contractors' schedule progress, labor utilization, cost expenditures, and labor productivity. Issues and problems affecting cost and schedule invariably arise, and contractors may attempt to cast blame for those issues and problems on the owner, and prepare requests for

time extensions and changes in scope. Often, the owner may have responsibility for these issues and problems. However, without a complete historical record and documentation from the contractor's files, the owner may not have all of the facts. Daily reports prepared by the EPC contractor and its subcontractors, inspection reports, and RFIs between the EPC contractor and its subcontractors often tell a different story as to the real cause of the problems and their effect on project performance. Also, this documentation could reveal concurrent delays for which the contractor is responsible and which could mitigate the owner's responsibility for the cost of certain issues and problems.

**RECOMMENDATION**: The owner must make a clear requirement in its contract with the EPC contractor of the contemporaneous documentation that the EPC contractor must submit to the owner during the project, or include in the project database to which the owner will have unfiltered access. It is much easier to obtain documentation from the contractor if it is specified in the contract than requesting this information only after issues and problems arise. Therefore, owners should anticipate the need for the contractor's documentation in the contract requirements, and establish a procedure to obtain such information in the normal course of contract administration and not only after problems and issues arise.

PROBLEM

**6. Multiple change orders are approved during the project or remain unresolved until the end of the project, leading to large delay and cumulative impact claims for recovery of lost productivity costs.**

Contractors may sign off on early change orders without including extra costs for productivity loss and cumulative impact from multiple changes. However, after numerous changes have occurred, contractors who were lax on recognizing the potential for such costs will notify the owner that they reserve their right to submit a cumulative impact claim to recover additional costs beyond the costs that were previously agreed in prior change orders. Owners resist such tactics, and disputes may occur which do not get resolved until after the project is completed, and often in the courtroom or arbitration hearing.

**RECOMMENDATION**: Owners should include proforma change order forms in their contracts which include full accord and satisfaction language that makes clear that the agreed price of the change is to include any loss of productivity, delay, cumulative impacts, acceleration, and all other direct and indirect costs that arise from the changed work and the effect on the unchanged work. With this information, the contractor is clearly on notice that cumulative impact claims at the end of the project will not be considered valid. However, loss of productivity resulting from the cumulative impact of changes may be considered indirect disruption which is not foreseeable. Thus, even with contract language stating that the change order costs are to include cumulative

impact costs, a contractor may still attempt to argue that such impacts were not foreseeable and, therefore, when they became known, it has entitlement to additional compensation for the costs of such impacts.

If the owner will not accept cumulative impact productivity loss man-hours and costs in the change orders, and require the contractor to sign the change orders without such costs before it receives payment for the additional or changed work, then the contractor should include in its transmittal letter with the change order, or in a separate letter, that it reserves its right to later make a claim for such productivity loss.

Owners should also require that the change order documentation from the contractor include a direct and indirect man-hour breakdown by discipline. Cumulative impact claims are usually evaluated by comparing the change order man-hours to the base scope man-hours. Without the change order man-hours, the owner does not have all of the information that it may need to perform its own evaluation of potential claims for the cumulative impact of multiple changes.

Absent contemporaneous productivity data, *i.e.*, contemporaneous man-hour and installed quantity data, the contractor will not have the best data to support a productivity loss claim that results from the cumulative impact of multiple change orders or other causes of productivity loss. A measured mile analysis of the contractor's productivity data is often considered the best type of analysis to support a productivity loss claim. This analysis compares the contractor's productivity during an un-impacted period to the contractor's productivity when the owner-caused impacts occurred. The difference represents the productivity loss caused by the impacts. Therefore, the contractor's management should require its field personnel to collect man-hour and installed quantity data on a weekly basis throughout the duration of the project.

PROBLEM

**7. Insufficient management of multiple prime contractor design and construction interfaces, leading to design changes, delays, and cost overruns.**

Owners often place responsibility on multiple prime contractors to coordinate and integrate their design and construction work to avoid interferences and delays. While such contractual language is commonly used, one contractor cannot require another contractor to do anything which may alter its design or method of construction performance. If such consequences occur, the affected contractor(s) will seek recovery from the owner for its time and cost impacts of such coordination and integration, and any changes that result from ambiguous design and/or construction responsibilities that are assigned to the various contractors.

**RECOMMENDATION**: The owner should be proactive when it receives the detailed design documents, work plans, and schedules from its various prime contractors and attempt to anticipate such interface problems. The owner's management team should be an active participant in coordination meetings between contractors and attempt to amicably resolve problems rather than relying on contract language that states that the contractors must coordinate and resolve problems. An overall EPCM contractor may be a better strategy if the owner's management team is stretched too thin to accomplish the identification and control of interfaces between multiple prime contracts.

PROBLEM

**8. Owners often do not have a sufficient number of experienced personnel to manage the technical aspects of a project, leading to delays in reviews of design and procurement packages, and late responses to requests for information from the contractor.**

Contractor delay and disruption claims often arise because the owner does not respond in a timely manner to documents submitted by the contractor for owner review and approval, or to RFIs requiring clear responses and direction.

**RECOMMENDATION**: Owners need to ensure that their technical and project management team are adequately staffed to review documentation and provide adequate responses in a timely manner. Requiring the contractor to include all owner review activities in its schedules will enable the owner to better anticipate the timing of such requirements. The owner should also require that no owner-responsible activities are within a reasonable number of work days (ten would be a good number) of the critical path on the baseline schedule, and then the owner should closely monitor those owner-responsible activities as the schedule is updated to be aware if such activities become critical as the work progresses. As for RFI responses, the owner should conduct a cold-eyes review of the design package before the contract is let to avoid problems with the information provided to the contractor. The contract procedures should also define a reasonable period for the owner to review RFIs and provide an adequate response and direction to the contractor. Also, the owner could utilize a review period up front in the contract schedule such that the contractor must have all of its information requests submitted during this time period or waive its right to time extensions if later requests are made that could have been made in the earlier period.

Another strategy that the owner could employ is to have contract language that defines the number of days that the owner has to review and submit comments on the contractor's submittal packages, after which the contractor's submittals are deemed to be approved and the contractor is entitled to proceed with the follow-on work. Also, the owner should include a contractual provision that limits the number of submittals (drawings, specifications, purchase orders, etc.) that the contractor can submit during any given period to not overload the owner's review team.

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PROBLEM

**9. Inadequate baseline schedule development and updating by contractors, leading to unreliable progress measurement, uncertain critical paths, and inability to mitigate delays.**

If the contractor's baseline schedule: 1) does not adequately define the period of performance for all scope requirements; 2) contains logic errors and excessive constraints; or 3) is inconsistent with its bid basis, *i.e.*, activity durations do not match the man-hours determined by the contractor's bid estimate to perform a given activity, the baseline schedule will be flawed and not useful to measure the contractor's work progress. The baseline schedule problems could carry over to the schedule updates, and the schedule problems could be compounded by insertion of incorrect progress and/or inaccurate actual start and actual finish dates for activities. Also, an inadequate baseline schedule and schedule updates will not provide a valid basis for determining if critical path delays have occurred which may entitle the contractor to a time extension or compensable delay. Likewise, an inadequate baseline schedule and schedule updates will not provide the owner an adequate basis to determine if acceleration should be performed on a paid basis, or provide a proper basis to determine if the owner is entitled to liquidated damages after considering the contractor's entitlement to a time extension.

**RECOMMENDATION**: Owners should consider a review of the quality of the contractor's baseline schedule and periodic schedule updates by an experienced forensic schedule delay analyst to determine if problems exist. Items of concern include the following:

- Does the schedule include activities for all scope requirements in the contract?
- Are there excessive activity durations, indicating that insufficient detail has been provided in the schedule to enable accurate measurement of progress?
- Does excessive float exist on activities, indicating optimization of the schedule logic may be appropriate?
- Do excessive negative lags exist between activities, suggesting a change from a finish-to-start relationship that creates the negative lag to a start-to-start relationship between the activities or a change in the link to a different activity?
- Is there a significant difference in the planned v. actual labor resources, indicating potential loss of productivity or potential problems with the bid?
- Is there a large difference in the planned duration compared to the actual duration of a significant number of activities, indicating delays have occurred or the planned basis for activity durations was in error?

- Is there a large difference in the planned lags between activities compared to the actual lags of a significant number of logic ties, indicating delays have occurred or the planned basis for lags was in error?
- Was there a change in the schedule calculation mode from "retained logic" to "progress override", or vice versa, indicating that the basis for forecasting the project completion activity has changed, which may be unreliable?
- Is there an excessive use of constraints, such as "start-no-later-than" or "must-finish-on" constraints, and has the reasoning for these constraints been examined and justified? An overuse of constraints may cause an inappropriate calculation of the critical path for completion of the project.
- Do all activities have at least one successor (except the final activity) and at least one predecessor (except the first activity)?
- Have new activities or increased durations of existing activities been included for Change Orders?
- Was the engineering percent complete value and quantities of material received at the start of field construction or major fabrication checked to be sure that the progress is consistent with the contract basis for progress measurement?
- Do any activities have large negative or positive lags in the relationships? Activities with large positive and negative lags should be identified, as they can distort the logic. Can large positive lags be better represented by adding new activities?
- Do any activities have progress but no actual start date?
- Are any activities completed without an actual finish date?

PROBLEM

**10. Owners do not develop a sufficient and reliable integrated Master Project Schedule that results from pulling together the work activities from multiple prime contractors.**

Inadequately prepared contractor schedules, if integrated "as-is" into an overall Master Project Schedule, may provide false calculations of the overall critical path of the entire project. Also, if the activity interfaces between various contractors are not properly identified, delays by one contractor may not properly show the resulting impacts to other contractors. Thus, delays may go

unrecognized and mitigation options are diminished until corrections to the Master Project Schedule are made.

**RECOMMENDATION:** Owners should first determine if the schedules that are developed by the prime contractors are properly prepared and devoid of schedule logic or critical path calculation problems as identified in Item 9 above. Then, a thorough review of the need for activity ties from one contractor's activities to the activities of other contractors should be performed, and additional relationships should be added, where necessary, to fully integrate the schedule.

PROBLEM

**11. Insufficiently sized camp facilities for housing the onsite construction work force and the owner's startup and initial operations personnel on remotely located projects, leading to delays and large cost increases for additional camp construction or hostels.**

On remotely located projects, the size of the camp that is needed to house the construction direct and indirect labor required to build a project may be understated. The camp sizing is often determined based on a premature estimate of the required labor to complete all work activities required to complete the project. Labor force sizes are often underestimated because of premature estimates of the quantities of materials required for the project, such as civil earthwork, and quantities of concrete, structural steel, piping, electrical, and instrumentation. If the quantities increase significantly after the camp size is established, then more construction man-hours will be required.

Also, unrealistic assumptions regarding construction labor productivity can result in the need for significantly more construction labor man-hours or more workers to complete the project by the completion date established for the project. Increased labor requirements can then lead to additional loss of productivity and increased costs as a result of crowding, trade stacking, dilution of supervision, and acceleration measures to attempt to maintain the completion date. If the owner's start-up and operations team arrives at the project site when it was originally planned, additional beds may be required if the construction has been delayed or additional labor was added to perform the project work. This too becomes a problem if the camp was too small to handle these additional personnel at the project site. Options include bringing in hostels or building additional housing structures to provide more bed space, or working longer hours and/or multiple shifts to perform the increased work scope, or delaying the completion of the project.

**RECOMMENDATION:** Owners should avoid a premature establishment of the camp size requirements for a project until the equipment and materials that will be required for the project can be accurately quantified. Also, owners should scrutinize the contractor's basis for estimating

construction labor productivity. What was the actual labor productivity on prior projects in the area where the project will be built? Will imported labor from other countries be required? What is the direct vs. indirect labor ratio assumed by the contractor for the entire site work force, and is this realistic based on the qualifications and experience of the expected labor planned to be used to perform the project work? Is the contractor's CPM schedule resource loaded with the labor man-hours resulting from the most accurate contractor estimate for the labor requirements needed for the project? Is the contractor's CPM schedule accurately prepared so that the peak labor needed for not only the early start dates but also the late start dates indicated in the schedule can be determined and used as a basis for camp size? All of these factors will directly affect the size of the camp needed for the project and should be thoroughly vetted to ensure that the peak labor work force can be accommodated.

PROBLEM

**12. For offshore oil & gas projects, incomplete onshore fabrication prior to shipping leading to large amounts of carryover work offshore at much higher costs.**

Decisions are often made by owners and their contractors to "sailaway" the components of their offshore oil & gas project being fabricated and assembled onshore in various fabrication yards before all of the required work on these components is completed. These larger components include topsides decks and hulls, which weigh hundreds of tons or more. Enormous transport vessels are needed to carry these large components to their offshore installation locations. Decisions to complete the work offshore are often made so as to not miss the window of availability of the limited number of large transport vessels. While the cost of completing the work offshore is more expensive than it would be onshore, the cost of missing a transport window can include large demurrage charges or delay to the project while waiting for another transport vessel to become available.

**RECOMMENDATION**: Owners should carefully review the accuracy of the contractor's progress reports and work to complete forecasts in their schedules and progress payment requests. Also, the contractor's schedules should be evaluated to determine if they are properly prepared and void of schedule logic or critical path calculation problems as identified in Item 9 above. Significant change order requests by the contractor, large changes in the required quantities of installed equipment and materials, large weight changes of the topsides decks or hull, and significant decreases in the contractor's labor productivity are indications that the completion date may slip, carryover work may be necessary, and plans may need to be prepared to complete the fabrication work offshore.

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PROBLEM

**13. Failure by owners to have a sufficient and experienced management team in place to manage change orders, requests for time extensions, and claims. After the initial good feelings at the beginning of a project are over, contractors often become aggressive and submit change orders and claims if they feel entitled to additional cost recovery. The owner's project team then becomes upset with the contractor, and the project relationship suffers.**

Owners often do not have sufficiently qualified and experienced engineering, construction, and project management personnel to manage a large EPC project. They may, however, proceed with a project thinking that: 1) the lump sum EPC contractor will properly perform all of the necessary functions, 2) they will select an EPCM contractor to act as their agent to execute the contract and hire individual specialty contractors to perform the construction work, or 3) they will seek to bring in a team of experienced personnel who come from other corporate cultures but have not previously worked together. This owner's team is now charged with managing the lump sum EPC contractor, but must first develop the procedures to do so.

**RECOMMENDATION**: In any of these scenarios, the owner should implement a robust Claims Prevention Program that includes the following components:

- Quality Contract Documents;
- Management of Outside Design Professionals;
- Constructability and Biddability Reviews;
- Site Investigation;
- Review and Approval of Detailed As-Planned Schedules;
- Claims Mitigation During Construction; and
- Project Reviews.

### Quality Contract Documents

The successful project manager is an effective manager of contracts. From the owner's point of view, this involves three basic steps:

- Development of contract documents which provide a clear and nonconflicting basis for a contractor to assemble a responsive and competitive bid. The contract documents must reflect the intent of the project in language that is unambiguous and provides a basis for a contractor to plan its means, methods

and sequences. Production of plans and specifications merely to satisfy owner goals of form and function is no longer the single objective.

- Contract administration has taken on new meaning. It is not only the enforcement of the terms and conditions but also includes the use of the terms and conditions to adapt to the changing environment, ongoing contract interpretation, and management of decisions that are necessary to keep the project moving forward. Both the contractor and the engineer have duties under the terms of the contract.
- Perhaps the most important step and the one most frequently overlooked is the importance of record keeping or documentation. Does the engineer have the hard facts to support decisions made during contract interpretations and to defend against unreasonable allegations on the part of the contractor expressed in the wording of a total cost claim. Without documentation, the engineer representing its owner is at the mercy of the courts.

The vast majority of claims are based on errors, omissions, conflicts and ambiguities in the contract documents and/or erroneous interpretation of those documents. The engineer is in the middle of this process. No longer can claims be put off as an element to be resolved after the project is completed. The increasing exposure of the design professional makes it necessary for that design professional to take an active role in a claims prevention and mitigation program.

The design professional plays a major role in a claims prevention program prior to award of the construction contract. After all, the documents prepared by the design professional are more often than not used as the basis for a claim. Design professionals are not perfect. There will be errors, omissions, and conflicts. The secret of a successful claims prevention and mitigation program is to minimize those errors and omissions and then to respond positively and reasonably when an error and/or omission is uncovered.

A claims prevention review focuses on the principal causes of contractor claims. Value engineering and constructability reviews, on the other hand, focus on alternatives to reduce costs yet accomplish the same overall objectives. These alternatives typically involve means, methods, materials, form, equipment selection, etc. A claims prevention review focuses on potential errors, conflicts, omissions, ambiguities, and misrepresentations both in terms of the contract documents and the system to administer, interpret, and manage those contracts.

It is important to recognize what is not included in a claims prevention review. A claims prevention review does not look at better or less expensive ways to accomplish the objective. It does not address the technical adequacy of the solution. It does attempt to find and recommend elimination of potential causes of claims.

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The following questions during the claims prevention review help to evaluate the adequacy of the contract documents:

- Are the contract documents clear, complete and enforceable?
- Does the contract language use the common and normal meaning of words?
- Have the contract documents been reviewed to ensure conflicts do not exist between various sections?
- Do the contracts use exculpatory language inappropriately?
- Are the contract documents fair and reasonable?
- Do the contract documents allocate risks to the party best able to control those risks?
- Have the architectural and engineering disciplines taken sufficient precautions to ensure the design is reasonably free of errors?
- Do the contract documents adequately support the terms of payment selected, *i.e.*, fixed price, cost-reimbursable, etc.?
- Are expectations clearly communicated?

**Management of Outside Design Professionals**

Owners often use the engineering services of engineering and construction companies and private design firms for preparation of these contract documents. Such professionals are not deemed to be perfect and do not warrant that their plans and specifications are 100 percent free of errors and omissions. Liability of design professionals for errors and omissions is beyond the scope of this article.

Common causes of problems that owners experience with professional contracts include the following:

- Incomplete scope of work;
- Misunderstanding of work plan and the responsibilities of the parties;
- Unclear performance criteria;
- Interference and change by the owner;
- No internal quality assurance system by professional designer;
- Lack of independent reviews of professional work products;

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- Lack of coordination between subconsultants;
- Inadequate selection procedure;
- Lack of an agreed-upon schedule for professional performance; and
- Conflict between the professional as an agent and the professional as an independent contractor producing work products.

Of all of these causes, the most common problem is failure due to differences in expectations between the parties. Design professionals are contractors and must be managed by contract. This management involves development of a scope of work, performance criteria, budgets, and schedules − all of which form the basis for a meeting of the minds.

Much of the responsibility for the details of the scope of work should rest with the professional. Has the owner required that the professional submit a detailed work plan describing the who, what, where, when and how of the professional's approach to meet the requirements of the owner? Is there an adequate selection procedure that identifies the design professional firm that is best qualified to perform the particular scope of work?

A selection process for the design professional should contain as a minimum the following:

- Internal review of the scope of work to determine that it meets the requirements of all parties within the owner's organization and adequately describes expectations.
- Requirements for a proposal format that includes: the approach to be taken, a work plan, personnel to work on the job, previous experience in similar work, references, and cost data as required by the owner.
- A formal review and selection process of an unbiased committee to screen written proposals and select three to five firms for oral interviews.
- Requirements that personnel who will actually work on the project give the oral presentations rather than salesmen or marketing professionals.
- An independent committee that receives the oral presentations and makes recommendations to management for award.
- If procedures allow, selection should be made upon the basis of qualifications, personnel, technical competence, and experience in similar work, etc. Negotiations can then be conducted with the top-rated firm to arrive at a price. If negotiations on price are not successful, then negotiations can move to the next rated firm on the best-qualified list. In any event, once selection is made, the contract must be managed by the owner. Changes must be controlled and

work products subject to scrutiny for independent review, preferably by those who will be responsible for its construction in the field, i.e., the resident engineer and the inspectors.

The role of the professional during construction should be specified. That role is usually limited to review of submittals, responses to requests for information and design clarifications, and occasional monitoring of work to determine that specific elements are being furnished and installed in accordance with the designer's intent. Owners must be careful when placing the design professional in a position as an agent of the owner, making decisions concerning the professional's work products. This occurs when the design professional is given construction management responsibilities. The concern here is the inherent liability for construction problems resulting from design issues and the objectivity of the design firm in dealing with such problems.

**Constructability and Biddability Reviews**

The basis for bid must not only be clear as to design intent, but also be a clear basis for constructibility and biddability. Resident engineers and inspectors can provide a great service at this point by addressing the following:

- Specifications and divisions are appropriate and per a standard format;
- Procedures for substitutions are clear;
- Appropriate material and equipment standards are specified;
- No sole source or brand name materials or equipment are specified;
- Technologies and notations are consistent;
- Plans and specifications allow a broad selection of appropriate construction means, methods and techniques;
- Cross-references of drawings and specifications are complete;
- Complete descriptions are provided of everything to be furnished by the owner with a schedule of delivery;
- Definitions are provided for items of work to be performed by each contractor for multiple contracts;
- Definitions of quality control responsibilities of contractor and owner are provided, with clear statement of tests and access required;
- Submittal requirements are clear;
- Review period for submittals is identified and appropriate;

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- The construction schedule is feasible and clearly defined with schedule interface points identified;
- Completion times are specified;
- Supplemental data is referenced;
- Disposal requirements of excess material waste cleanup are identified;
- Divisions of work are clearly identified at contractor interfaces;
- Drawings are sufficiently detailed and work is clearly defined;
- Structure of bid form, bid schedule, etc., are clearly defined and unambiguous;
- Proper units are used for bid items;
- Bid items are clear as to the scope that they cover;
- Bid quantities are reasonable for work scope defined;
- Bid items are coordinated with drawings and specifications;
- Measurement and payment mechanisms are clearly defined and reasonably coordinated with bid items; and
- A change order procedure is spelled out and basis for adjustment is identified.

**Site Investigation**

A thorough site investigation by the contractor is essential to ensure all site-specific information is collected for preparation of its bid estimate. If the contractor fails to perform an adequate site investigation, many of the impacts that may affect the contractor's time and cost of performance may not be recognized. If such conditions would normally be identified and recognized by a prudent and experienced contractor through a site investigation, recovery from unanticipated costs caused by these impacts would normally be precluded.

A thorough site investigation would include the following categories of information:

- General site information, *i.e.*, soil conditions, utilities, subsurface conditions
- Detailed surface conditions
- Detailed subsurface conditions
- Permits, fees, and tax requirements
- Labor information
- Weather data
- Equipment and materials information
- Transportation information

- Pricing data
- Notes of meetings with owner's site representatives

**Review and Approval of Detailed As-Planned Schedules**

Creating a detailed as-planned schedule that identifies the scope of the work, the activity relationships, milestones and completion requirements is vital to the proper planning of a project. A contractor should perform the following tasks to review and check its as-planned schedules, ensure their completeness, accuracy, and reasonableness, and allow for their timely approval by the owner:

1. Verify that all work that must be performed is included in the schedule.
2. Check the level of detail proposed. Is it consistent and balanced throughout the network or is it vague in certain areas? Is the level of detail adequate to plan, schedule, coordinate, monitor, control, and report on the progress of work?
3. Check for compliance with all contract specifications related to the schedule.
4. Check to ensure that all owner-related functions outlined in the contract documents are properly incorporated. These include:
   a. Access and availability dates for physical areas of the project
   b. Intermediate completion dates established for follow-on contractors
   c. Delivery of owner-furnished materials and equipment
   d. Approval of shop drawings, submittals, and samples
   e. Inspections as required
   f. Joint occupancy dates
   g. Beneficial occupancy dates
5. Check the project milestones and constraints established in the network and identify if they are contractual, absolute, or preferential.
6. Check if restraints in the schedule logic create incorrect critical paths.
7. Evaluate past experience relative to this type of project. Spot-check relationships or work phases and their timing, *i.e.*, structural steel erected to job completion, setting of major equipment to job completion, etc.
8. When comparing the schedule for a similar job, are necessary activities included, are durations correct, and does the project duration fall within a reasonable variation range?
9. Perform a one-to-one data check to validate the consistency of the computer tabulation and the network logic if a CPM is used.

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10. Are the size and type of operation for each activity period clearly defined?
11. Are the activities sufficiently small in duration and scope for accurate time estimation and tracking?
12. Are the activity durations reasonable?
13. Are concurrent activities so scheduled?
14. Review the proposed logic sequence and note any exceptions that might be taken. Validate absolute logic conditions and confirm key preferential logic conditions.
15. Spot-check activity durations for quantities involved, crew-size requirements, and productivity factors. Challenge durations when appropriate.
16. Is it possible to complete each activity described in the allocated time, given the resources available?
17. Highlight the first five to seven paths of highest criticality (paths of least float) to review and understand the controlling logic and mathematics of the schedule. Determine if the critical path is proper and reasonable.
18. Check the plan to see if all major equipment and material restraints and delivery dates are properly reflected.
19. Is the lead time for submittals and approvals realistic?
20. Check for involvement of subcontractors and suppliers and see if they are properly reflected. Are dependencies clearly defined? Are critical deliveries included?
21. How is weather reflected? Are there any seasonal weather restrictions to consider?
22. Prior to submitting a detailed as-planned schedule for the owner's approval, obtain approvals from internal management team including:
    - Project Manager
    - Project Controls Manager
    - Operations Manager

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## Claims Mitigation During Construction

Successful claims avoidance results from prudent management activities. The following activities during the construction phase of a project are essential for both the owner's team and the contractor's team to mitigate claims and ensure the overall success of the project:

- Read and understand the contract documents;
- Implement a document control system to capture, code and file documents;
- Hold pre-construction meetings and reach agreements on key project objectives;
- Prioritize the relative importance of each objective;
- Define clearly the roles and responsibilities of each party;
- Allocate risks to the party best able to control those risks and provide equitable rewards for assuming risks;
- Develop performance criteria to communicate expectations and to measure each party's achievements;
- Coordinate activities involving several parties;
- Implement cost, schedule and quality control procedures;
- Hold periodic progress reviews and inspections; and
- Maintain open communications throughout the project.

## Project Reviews

During the execution of a project, it is prudent for a contractor's senior management team to conduct periodic reviews of project performance to ensure that: problems are being properly resolved; man-hour, cost and schedule information are being properly reported and analyzed to assure performance criteria are being met; changes are being properly estimated and sent to the owner for approval in a timely manner; comprehensive project documentation is being maintained; schedules are being updated and delays are being identified as to causes and responsibilities; and notices are being sent to the owner as required per the contract. In addition, major problems that should be brought to the attention of the owner at a higher level than the contractor's Project Manager should be dealt with immediately to mitigate or resolve significant issues.

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## About the Author

***Richard J. Long, P.E., P.Eng.,*** *is Founder of Long International, Inc. Mr. Long has over 50 years of U.S. and international engineering, construction, and management consulting experience involving construction contract disputes analysis and resolution, arbitration and litigation support and expert testimony, project management, engineering and construction management, cost and schedule control, and process engineering. As an internationally recognized expert in the analysis and resolution of complex construction disputes for over 35 years, Mr. Long has served as the lead expert on over 300 projects having claims ranging in size from US$100,000 to over US$2 billion. He has presented and published numerous articles on the subjects of claims analysis, entitlement issues, CPM schedule and damages analyses, and claims prevention. Mr. Long earned a B.S. in Chemical Engineering from the University of Pittsburgh in 1970 and an M.S. in Chemical and Petroleum Refining Engineering from the Colorado School of Mines in 1974. Mr. Long is based in Littleton, Colorado and can be contacted at rlong@long-intl.com and (303) 972-2443.*