Troubleshooting Engineering Progress Measurement

Introduction. It is a rare large project in the energy sector that manages to reach full issue for construction (IFC) status of engineering and design documents without experiencing questions and even strong criticism of the accuracy of stated engineering progress. This article discusses how a few, but far from all, progress measurement issues or problems frequently encountered by project teams can be avoided by following the standard, without "short cuts", approach to implementing engineering progress measurement.

Provided that the basic minimum requirements are implemented by the project team and used to quantify and measure physical progress for the project's contracted engineering scope of work, progress updates should provide reasonably good indications of current status.

Accurately reporting progress on a weekly and monthly basis is an important function. It is more important when progress payments are linked to the reported progress, and often carries unwanted liabilities when projects have significant changes or are canceled. If properly and methodically set up during the project initiation phase, correct tracking of progress is straightforward and can assist with identification of deviations from plan and meaningful trends in their work.

Among the many problems a team can experience if a reporting system is not correctly set up or when not fully implemented are a few that can derail a team's ability to forecast completion dates and total man-hour requirements. Not the least of which is a complete lack of confidence in the team by both management and client in reported status and forecast estimates.

1.   DEFINING BASIC REQUIREMENTS

Basic Requirements for progress measurement.   Engineering man-hours can be broken down into three categories for progressing, with each measured uniquely as explained in the following paragraphs: 1) hours to produce deliverables, 2) hours spent performing engineering activities, and 3) supervisory level of effort hours. For fixed price engineering contracts, reporting progress to the client of the deliverables is all that should normally be required. For reimbursable cost and internal contractor reporting, progress against all three categories should be considered a normal requirement.

Purpose of Engineering Deliverable Release Categories. A known progress reporting issue here involves depth of tracking. Tracking too much detail in the production steps for each category of deliverable, such as internal discipline checking milestones or rules of credit is likely to be too extensive and unnecessary. Going into greater detail than engineering document issue or release status burdens the project control team with confirming dates for each deliverable's interim steps. It also raises issues related to confirming the accuracy of interim dates not recorded in an electronic register. Not only are actual dates required, but forecast dates need to be updated when there's any variances between planned and actual achievement.

Normally the project manager and engineering manager will define each engineering deliverable's purpose, its category, and the process for how it will be issued both internally, such as for squad checks, and externally to the client. Typical examples of document release categories include:

IFR: Issued for Review
IFH: Issued for HAZOP or any other safety review
IFA: Issued for Acceptance
IFD: Issued for Design
IFI: Issued for Information
IFQ: Issued for Query/Quotation (or bid)
IDR: Issued for Squad Check / Inter Discipline Review
IFC: Issued for Construction

The use of document issue categories allows a confirmed and definite date to use for earned engineering progress. Some contractors may use other milestones for earning progress, such as intra-discipline reviews, but the dates for these milestones are often more difficult to validate or predict, and are seldom if at all, defined within the project schedule.

Establishing rules of credit (ROC) for engineering deliverables. Physical progress is made by achieving milestones planned for deliverables production steps as established by rules of credit (ROC) in an established, auditable and traceable manner. Dates are used as the method for claiming credit based on when the engineering deliverable is issued or released for some purpose within a document management system. Progress is therefore achieved on the earned basis method, not through the expenditure of man-hours.

Project specific needs may require adjusting a contractor's standard set of progress weighting for milestones, creation of custom rules of credit, or adherence to contract specified ROC. Contractors may also receive specific directions within the contract to issue documents to a client in accordance with specific instructions on what and how they want to review or approve certain drawings or documents.

The statusing of engineering documents begins, for example, with a design start activity, or a milestone. This represents the initial step and matches the early/actual Start date of the related schedule activity. Design start represents the effort required to review related preliminary drawings, determine applicable project standards and specifications, and the engineering scope of work involved for that work release. This is often the only date which is determined by the discipline design lead and not by an issue purpose date within the document management system.

After design start, the engineering manager will define how each of the contractor deliverables will be issued, as a minimum, in accordance with the deliverables issue category steps indicated in the contractor document control register.

The document control register and engineering deliverables. An issue here may be a document control register out of control, which could be the worst-case scenario. If the engineering manager does not exercise tight management of the register content, then scope creep is inevitable and engineering man-hours will be difficult to accurately forecast. Control is lost when discipline leads add, delete or change document numbers with little or no approval.

The document control register includes all documents, drawings and other deliverables that will be issued through the document management system, and defines how each document will be issued, including whether it is internal only or to the client. Listed engineering deliverables or documents are used as the basis for development of project schedule activities and are usually grouped and planned by types of drawings. They will typically be combined according to how they will be developed and split

into activities for issue purposes from design start to Issue for Squad Check, then Issue for Review, Issue for Approval and finally Issue for Construction.

Another concern may be failure of milestone dates to reflect the project's baseline schedule. If engineering discipline leads do not coordinate their milestone dates input with the project scheduler there is no guarantee that their dates accurately reflect the baseline schedule activities for the discipline.

The project schedule must be finalized and accepted for use as the baseline schedule before it can be used by the disciplines for determining planned ROC milestone dates for the drawing control register and discipline progress curves. This is important because it allows identification of variations from the approved plan, and if a positive or negative trend is developing.

Level of effort (LOE) and engineering activities. While deliverables will have rules of credit applied to them for progressing, activities supporting those deliverables do not. Budgeted hours are assigned to level of effort activities and progressed between 0% and 100% on a more subjective basis. Examples of engineering activities to be progressed, and typically included in the project schedule for tracking include, among others:

- Design work such as a HAZOP study, design review, 3D modeling reviews, or preparation of information,
- EPC scoping work such as bill of material or bill of quantities take-off, or subcontract development,
- Vendor document review work.

Hours budgeted to a discipline that are not related to work deliverables or progressable activities are progressed as "an hour burned is an hour earned". These budget level of effort hours are not to be comingled with hours budgeted to deliverables and their associated activities. Typically LOE hours are for supervision (planning and control) and they are to be collected and monitored independent of the work content budget by using their code of account designations. Once all hours for a LOE account are expended, the account is considered to be 100% complete whether additional hours are charged to the account or not. Design Leads need to pay particular attention to their discipline's hours charged as LOE since these budgeted hours are limited and can be easily over statused to show progress. While collected and measured separately, the sum of the deliverable and deliverable associated activities plus LOE content for a discipline make for that discipline's total progress base.

Allocation of budgeted hours for all categories. The project's engineering services approved budget estimate is allocated to some form of cost code of accounts (COA). Application of these budgeted hours is made to each of the deliverables and associated progressable activities within the COA. There may be other levels of definition for control to be considered as well. However accounted for in the estimate, the actual hours need to be tracked in similar detail for accurate performance measurement and reporting.

The budgeted hours, along with expended hours, are input into the progress measurement and cost reporting systems. The engineering discipline leads enter their budgeted hours for each document in the contractor's document management system, or however the status is being tracked. This allows earned hours to be calculated for each document based on achieving the appropriate milestone, which then sums up to any higher level necessary for reporting.

Once hours are allocated across all categories, actual earned hours can then be calculated, and progress measured. Prior to the baseline schedule approval, initial reporting may use preliminary progress curves developed from historical records or typical 'S' curves, but these should be labeled as "Preliminary" and replaced once the progress curves from the baseline schedule are produced.

2.   PERFORMING PROGRESS MEASUREMENT

Execution plan alignment. The project controls function is responsible for ensuring that progress measurement is aligned with the selected methods in a project controls execution plan. The responsibility for accurate progress representation for each budget element is with the applicable discipline lead. Project cost and scheduling analysts should in turn validate the discipline leads assessment.

Staffing levels may not relate to remaining engineering progress forecasts. An objective of the project controls function is to forecast whether or not the project will be profitable. Part of the basis of this forecasting ability are the planned staffing levels that are cross-checked against the remaining hours to earn and productivity calculations. If these do not closely align, then there are serious reporting issues that need to be resolved.

Cumulative manhour totals and comparison of budgeted man-hours against expended man-hours to date are key data in supporting this analysis. These budgeted and expended man-hours form the basis for the development of progress charts and S-curves for each discipline in accordance with standard project control procedures.

Utilizing progress measurement guidelines and rules of credit, project controls personnel work with lead discipline engineers to evaluate and report current progress activity, preferably utilizing an automated system based on actual document issued dates. Rules of credit milestones achieved against deliverables are credited and the sum of the earned budget is measured against the overall current or target budget as appropriate to calculate progress activity. Progress is calculated by comparing earned hours to budgeted hours. For example, 75 hours earned against a budget of 100 hours reflects the item as 75% complete.

3.   PROGRESS SYSTEM MANAGEMENT

Maintenance of earned manhour calculations. The effort required to measure engineering progress is relatively simple since the information is normally provided through a document management system. As documents are issued, for whatever release purpose, the dates against the milestones achieved automatically trigger earned man-hour calculations. For small contractors, an excel based system can provide similar functionality, although this lacks the auditability capabilities required by some clients.

Regular maintenance is necessary, however, when document numbers are changed, added to the document control register or deleted. It is very typical that documents are initially entered as place holders to be further refined as the project progresses, such as the final number of required plot plans, final structural details, etc., and time should be allocated for this activity.

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For questions or additional information on this topic email Ronald Smith, Director, Lumen PMC at rsmith@lumenpmc.com.