



EXPLO National Manual for Projects Management

Volume 7, Chapter 4

Project Schedule Curves Procedure



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Project Schedule Curves Procedure

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Project Schedule Curves Procedure

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Project Schedule Curves Procedure

1.0 PURPOSE

Schedule Curves serve the purpose of verifying the feasibility of CPM schedules in terms of resources (manpower and key commodities) requirements of all project activities over time. It analyses production curves, installation curves and resource profiles required to support the project.

They enable the scheduling and statusing of projects in terms of work volume, the other driver to project completion apart from critical path.

This procedure applies to works performed under all Government construction projects executed throughout the Kingdom of Saudi Arabia.

2.0 SCOPE

Schedule Curves shall be developed and maintained for all projects. The curves shall track all aspects of relevant quantifications, such as: deliverables (i.e. engineering documents), key commodities (such as: concrete, asphalt, pipe), staffing (such as: office personnel, construction workers), and overarching percent complete curves.

3.0 DEFINITIONS

Definitions	Description
Bulk Commodity Curves	Refers to design, procurement and installation of bulk material such as concrete and steel.
Family of Curves	Curves of different sources combined into a single chart for inter-functional reporting and analysis. (For example: Engineering, Procurement, Construction and Testing)
Key Commodity	Selection of representative commodities to be tracked on a particular project
Staffing	Labor requirements (Manual and Non-Manual)
Ramp-Up and Ramp-Down	Period of time with a rate of increase/decrease in staffing levels.
EPC	(E)ngineering, (P)rocurement, (C)onstruction.
Installation Rate	Units of measure of commodity installed in a period of time (tonnes/months, meters/day, ...)

4.0 REFERENCES

1. EPM-KPP-PR-000001 - Project Planning and Scheduling Definitions and Concepts Procedure
2. EPM-KPP-PR-000002 - Project Schedule Development Procedure

5.0 RESPONSIBILITIES

5.1 Lead Planner

In charge of having the schedule resource loaded, or using an alternate method, in order to develop the commodity installation, manpower, and progress curves.

5.2 Department Leads

Responsible to validate the commodity installation, manpower, and progress curves pertaining to their departments.

5.3 Project Controls Manager

Responsible to assure this process is followed.

5.4 Project Manager



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Needs to approve the commodity, manpower and progress curves for use.

6.0 PROCESS

6.1 Introduction

Schedule curves are not an 'automatic' output of a schedule network early dates. Curves produced by schedule software like MS Project and Primavera are aggregated from multiple scheduled activities, either looking at early dates, or looking at late dates, producing the extremes, or boundaries, within which a multitude of curves can exist.

While it is true that professional schedule software provides levelling capabilities, it is not straight forward to set up and produce consistent results. Consistency is an absolute requirement to schedule credibility. Therefore care should be taken to levelize schedule and curves.

Schedule curves have to be used in conjunction with schedules throughout the life of the project. Curves are produced during the bidding phase to verify attainability of proposal schedules in terms of staffing and bulk commodity installation rates. Once contracts are awarded, these curves are refined/adjusted and become control curves against which project performance is measured and controlled.

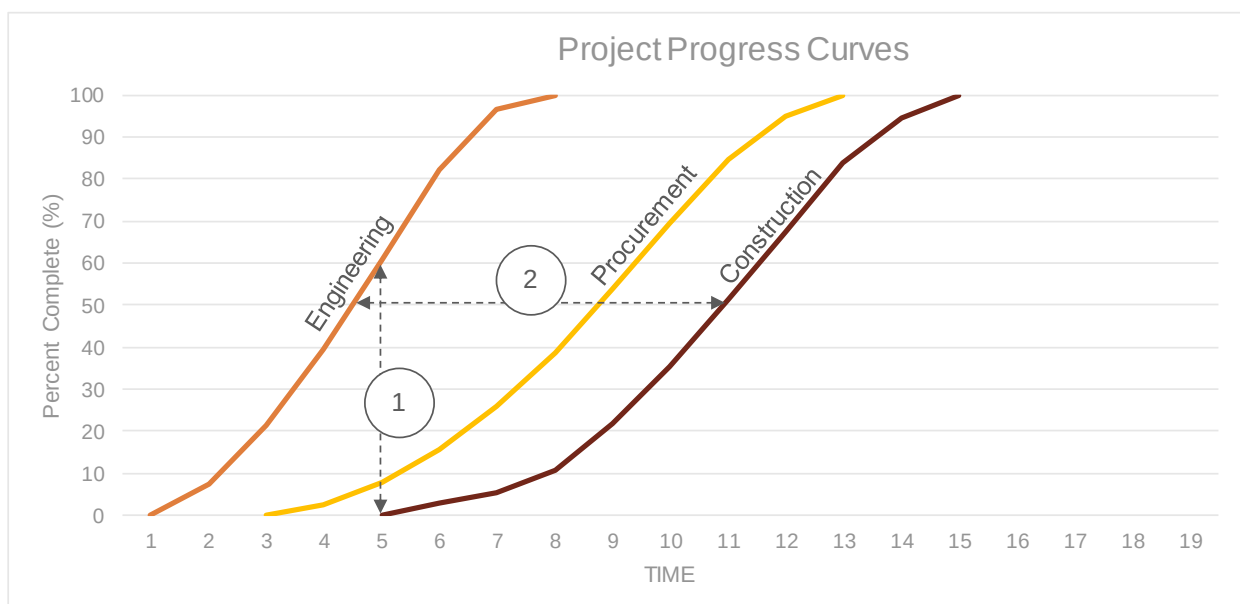
6.2 Source Information

Project Curves can come from a variety of sources, including control schedules. Trackers need to provide the capability to produce curves such as Engineering (document issuance, quantity release), Procurement (PO Awards, deliveries) Construction (Key Commodities installation, staffing) and Testing (System receipt from construction and turnover to client).

Curves from several sources can be combined into a single chart to produce "family of curves".

Family of Curves examples:

- Progress Curves Combining Departments, Project Level E,P,C (% based)



Checks that can be done with this type of family of curves:

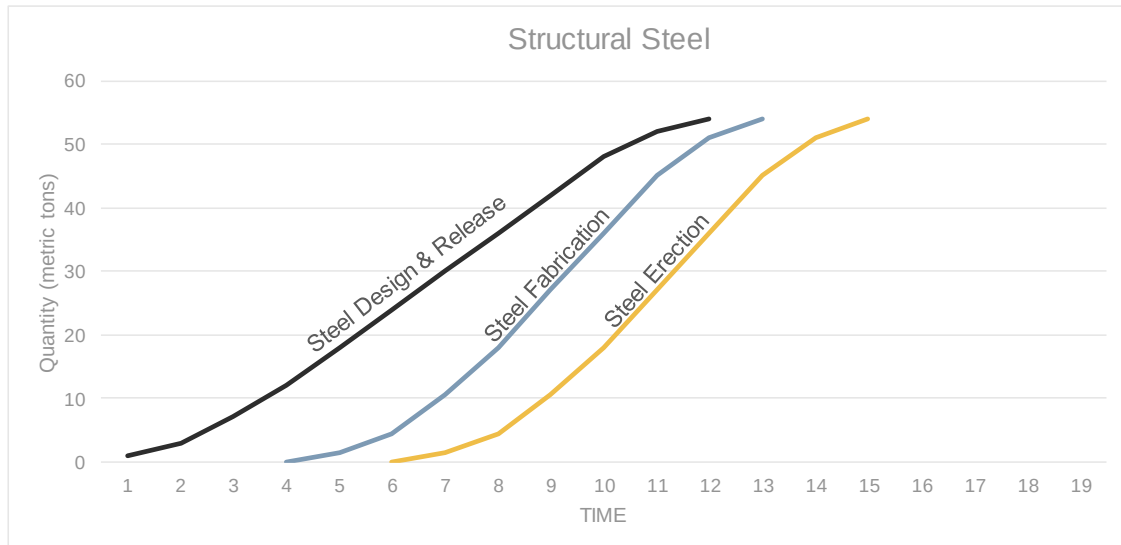
- (1) Making sure start of construction occurs only after engineering is sufficiently complete.
- (2) Ensure the time distance between engineering and construction is close to a year for large projects.



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Note: Strategic Planning's stage gate procedure actually requires engineering 100% completion before commencement of construction.

- Progress Curves Combining Departments, Commodity Level E,P, C (Qty based)

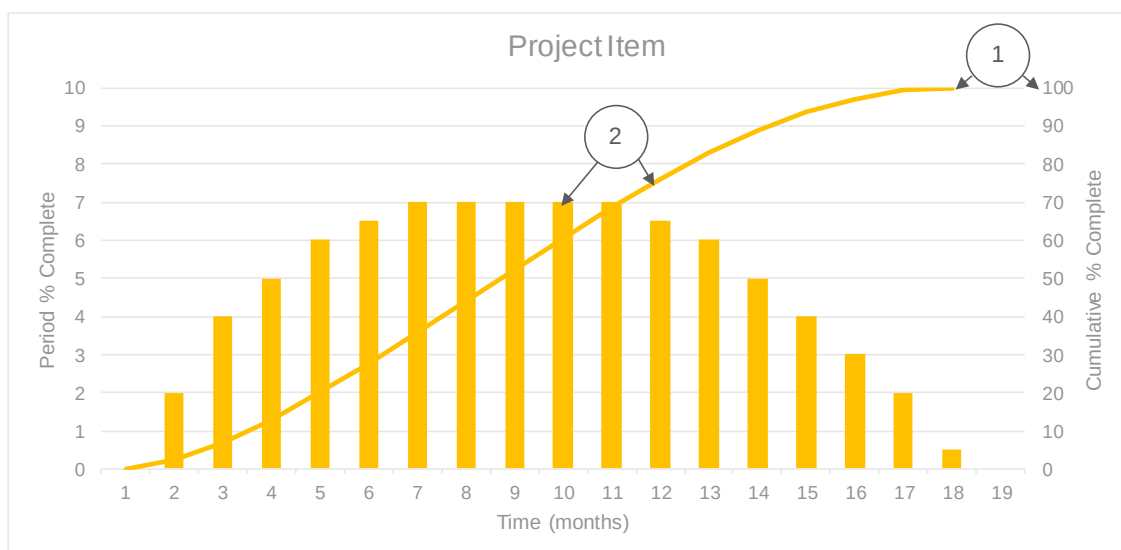


Checks that can be done with this type of family of curves:

- (1) Time distance between curves needs to be sufficient to accommodate things like: detailing of steel after design release, sourcing of raw steel material, steel fabrication, in shop inspections, shipping, customs clearance, ...
- (2) Fabrication capacity (tons/month) needs to be verified by the procurement department, and needs to be more than construction installation rate (tons/month).

Note: In this graph, the completion of engineering might be close to the completion of procurement (delivery).

- Progress Curves Combining Period and Cumulative Curves



Period values can be shown combined with cumulative values as spreadsheet graphs allow the use of multiple Y-axis. In example above, the left Y-axis shows period %, while the right shows cumulative values. Notes:



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- (1) It is best to show cumulative always on the right as the cumulative curve ends at that location.
- (2) Use same colors for same items. This allows for easy color association.

Once a project has established a baseline curve, this (or baseline curve update) needs to be shown in order to show actual and forecast against baseline plan.

6.3 Development of the Curves

6.3.1 By Department

6.3.1.1 Engineering

Engineering progress can be measured in two major ways:

- Issuance of drawings, specifications, material requisitions, service requisitions, ...
- Designed Quantities: as engineering issues drawings for construction (IFC), material take-offs are performed and budgeted quantities are corrected and released quantities get updated in a QTS for tracking purposes. Released quantities are a vital input to the commodity curves.

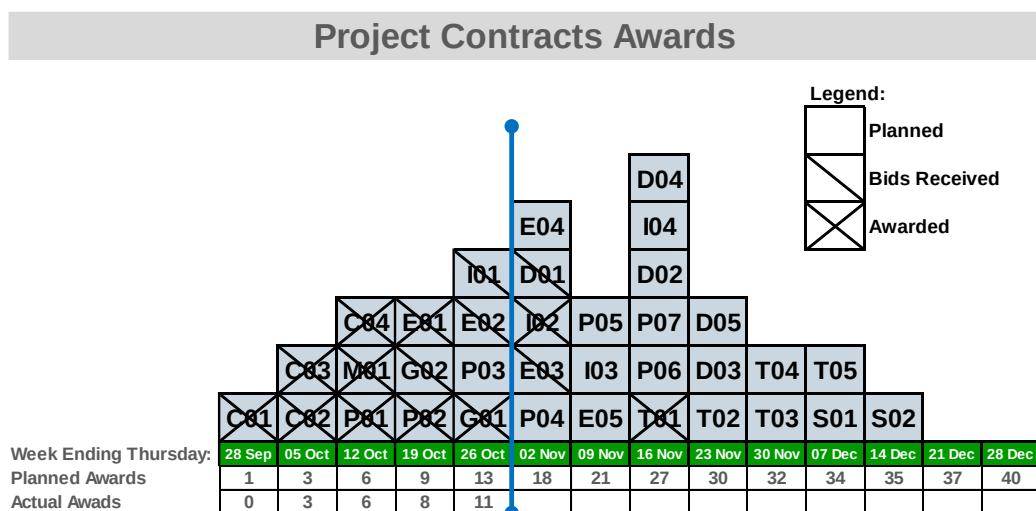
On large complex projects it is common to see both methods implemented to provide the best measure of total progress

6.3.1.2 Procurement Department

Procurement progress measurement focuses on two aspects: the purchase order formation process, and the fabrication delivery process. Separate curves are required to provide clarity. The formation process is mostly driven by Engineering and needs to be measured and compared to engineering deliverables and staffing, while fabrication and delivery is compared against construction commodity installation curves. Special attention needs to be given to Vendor Data submittals and separate tracking of vendor data is required.

6.3.1.3 Contracts Department

Contract formation is driven by design release and development of the contract scope of work. Because of this, both engineering and construction departments have significant involvement. Suitable progress “curve” would be a skyline of contract package awards or a family of curves showing packages issued for bid and package award. Below is an example of a skyline of contract awards:





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6.3.1.4 Construction

Construction progress is measured based on installation of commodities significant to project success. In addition to quantity installation, progress curves should measure delivery of materials, and manual labor staffing levels needed to achieve installation curve.

Construction curves shall be the primary driving curve to which everything else aligns. In other words: construction drives procurement, which then drives engineering. Construction commodity curves need to be established having realistic ramp ups and ramp downs, and achievable installation sustained rates.

Once established, the curves will form the “baseline” used to measure and compare the actual installed quantities from a quantity tracking system.

6.3.1.5 Testing & Commissioning

Testing & Commissioning cannot be directly compared to construction, as construction is quantity driven, while Testing & Commissioning is system driven.

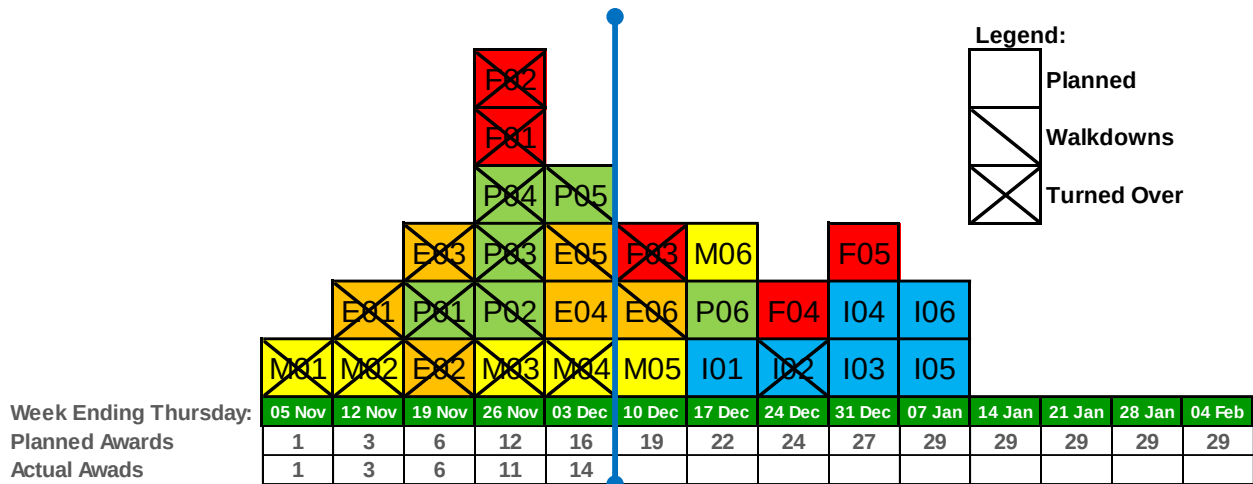
In order to track construction progress on systems, turnover packages need to be developed by the Testing team and tracked accordingly. Because systems are not quantity based, the most suitable “curve” for tracking system turnovers is a skyline.

These skylines have two phases (two separate skyline curves): turnover from construction to the Testing group, and Testing completing systems for turnover to client.

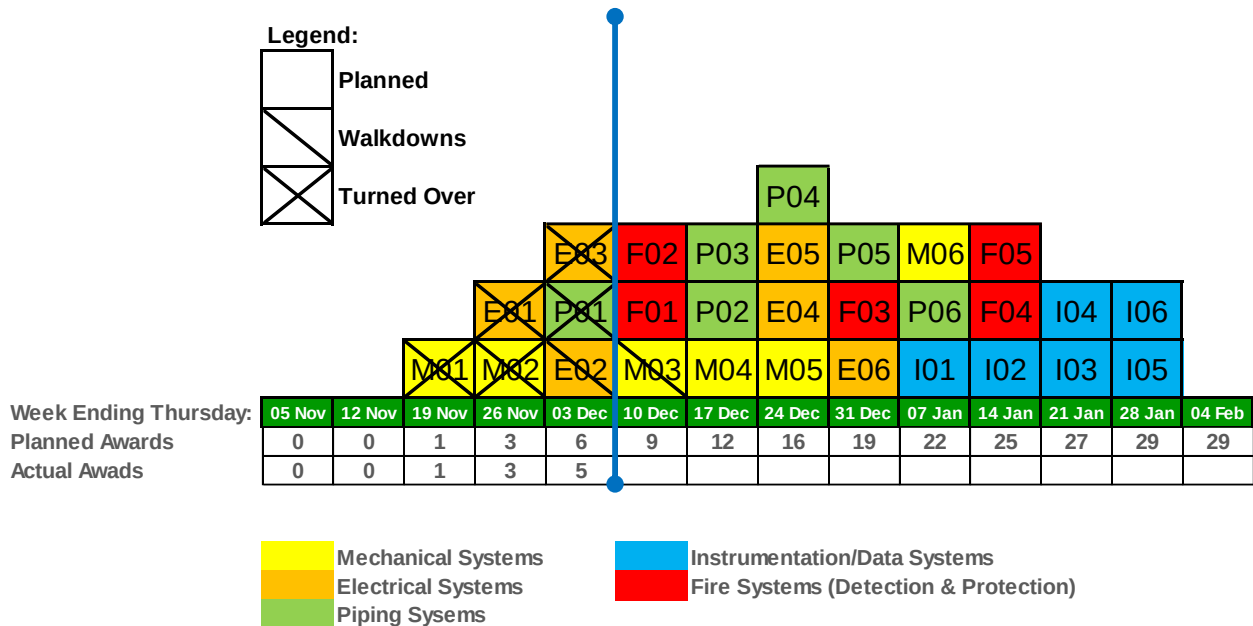


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Project System Turnover from Construction to Preop Testing



Project System Turnover from Preop Testing to Client



6.3.2 Project Level Curves

Curves prepared to summarize to project level are mostly used for management reporting to clients. These curves are inappropriate for managing the project. The classic curve is a project percent complete curve. The project percent complete curve is made up of curves for engineering, procurement, construction, and testing and commissioning. The weighing of each **E, P, C and Testing** departments is either based on manhours, or has an agreed weighing.

Weighing is not very critical to the progress reporting, as it is not the absolute value of progress that conveys the message, but the actual value against the planned value. In other words, a progress of, say 40%, provides a subjective impression of progress, but compared to a planned value of 35%, clearly indicates a problem. If a different weighing produced values such as 50% actual against 45% planned, shows that the absolute value is irrelevant, it is the comparison to the planned value that provides the message.

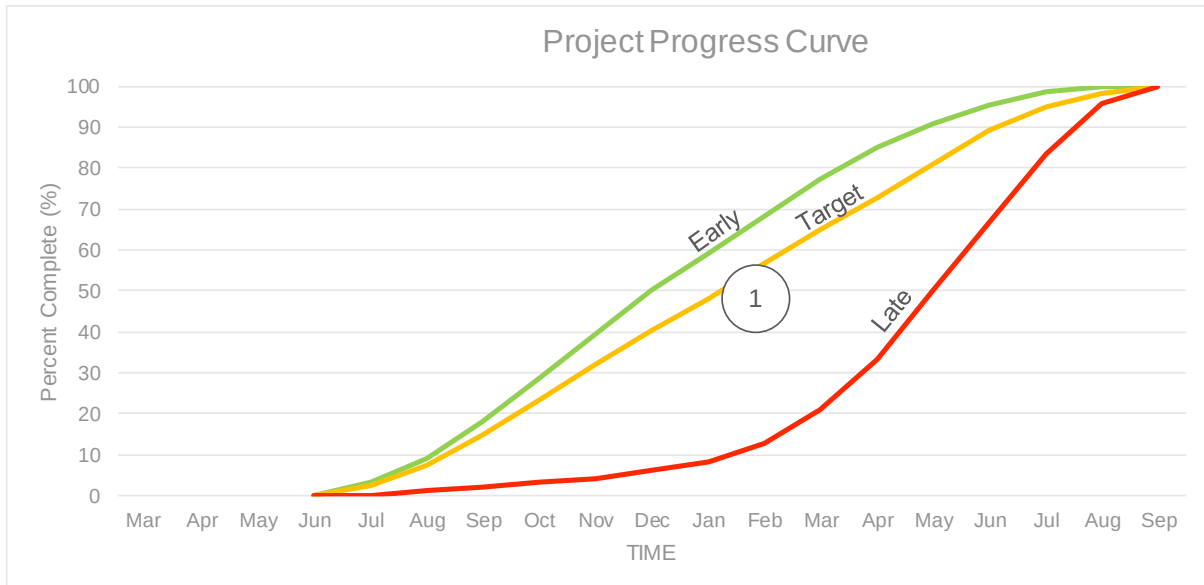


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6.4 Levelling of Curves / Targeting of Curves

Resource output from the different scheduling software systems is oftentimes jittery, not practical, or simply wrong.

Because scheduling systems can be onerous with the amount of detail they contain, the target curves can be established manually within the limits of the early and late starts and finishes the scheduling systems will permit. This allows for timely generation of project targets. It is far more important to establish targets soon than to try and have everything perfectly align to the lowest level of detail.



example above, target curve (1) is approximately 1/3 off early, and 2/3 off late. But it cannot be a mathematical calculation. It is far more important to provide: smooth ramp-up, even sustained period, smooth ramp down, a start more aligned towards early, and a finish more aligned to the late, in order to provide the project realistic staff numbers to which indirect support can be aligned (staff mob and demob, camp and kitchen sizing, staff transport, etc).

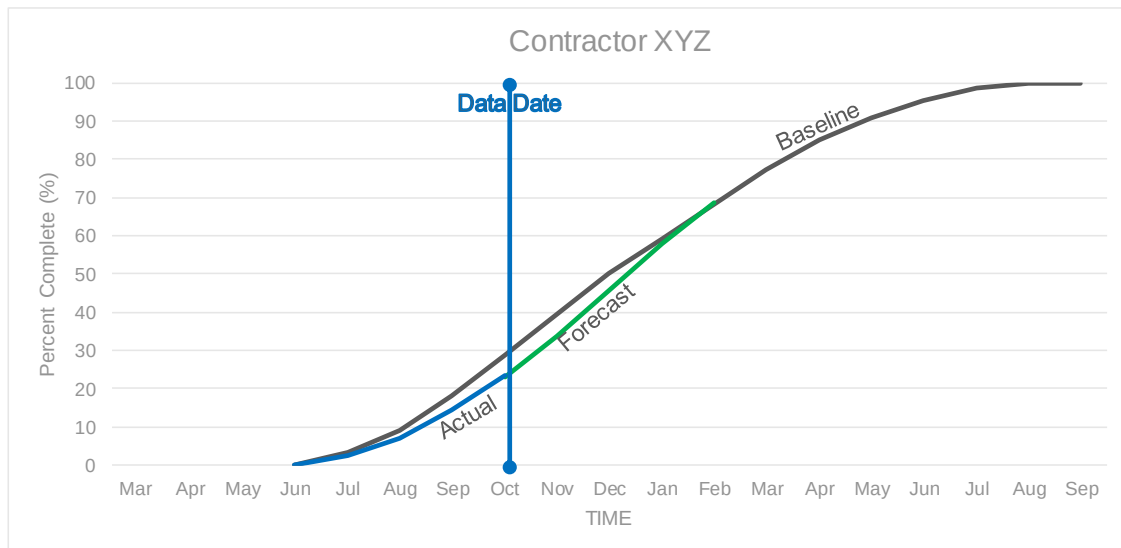
6.5 Baselining of Curves

Once the curves are established, reviewed and deemed achievable by the team, and approved by project management, the curves need to become the baseline that henceforth the curves the project gets compared. Baseline curves can only change through scope changes.

At this point, early and late curves get excluded from view to avoid confusion and a Data Date line gets added to clearly show actual to-date, and forecast.



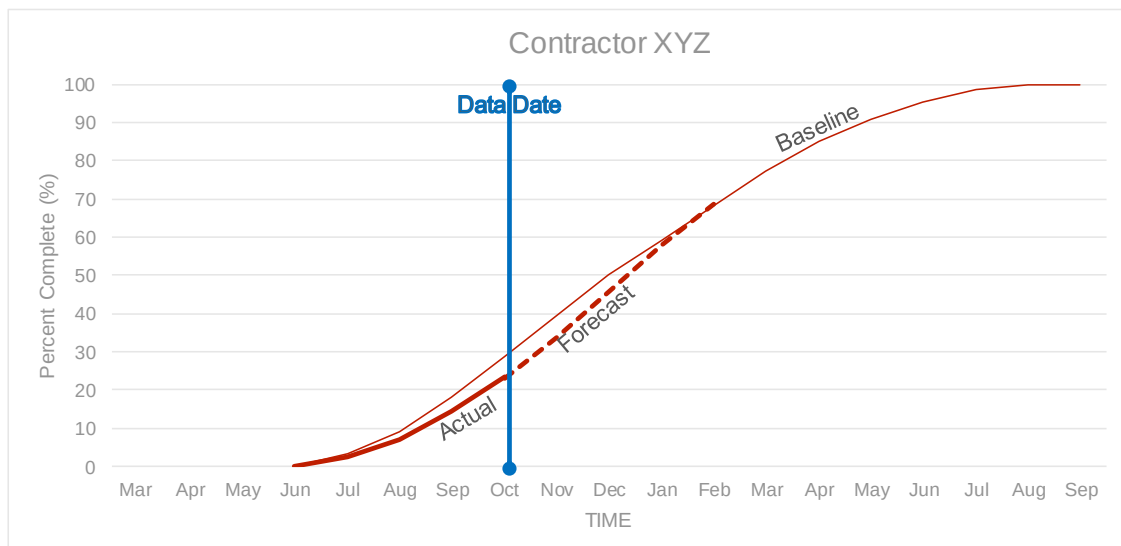
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In example above, actual curve shows progress falling behind the baseline. Project / Contractor necessarily need to identify the restrictions, mitigate the impacts, and develop a recovery plan that will allow regaining progress to baseline levels.

It is not acceptable to simply “fix” the schedule to show recovery. True mitigation measures need to be decided upon by the team and management, actions implemented, and effectiveness of those actions tracked.

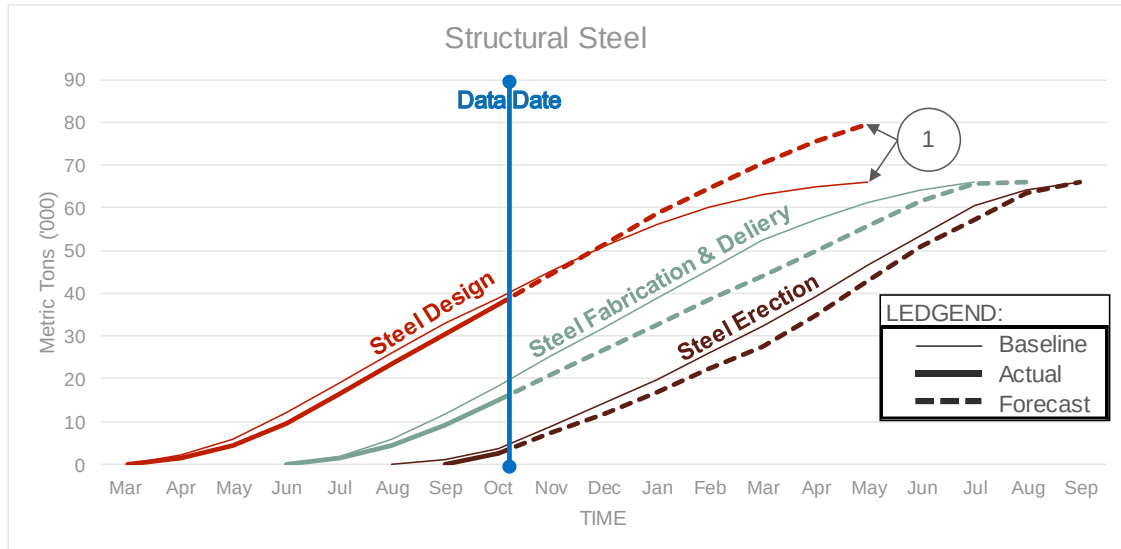
Note on colors: care need to be taken in choosing colors when building these curves. If no color strategy is implemented, graphs will suffer from color overload. In cases where families of curves are developed, it is better to keep a single color for an item, for example a commodity. Baseline, Actual and Forecast share the same color, but can be differentiated by choosing line types, for example as follows:



This allows building family of curves with Baseline, Actual and Forecast information as follows:



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As a side comment, note (1) on above graph depicts a discrepancy between total baseline quantity and forecast quantity. It's OK to represent this discrepancy during the course of design evolution, and simply means that actions need to be taken to change purchase order amounts and contract amounts/ plans to reflect this new quantity. To have a control of this process, it needs to go through the trend (change management) program.

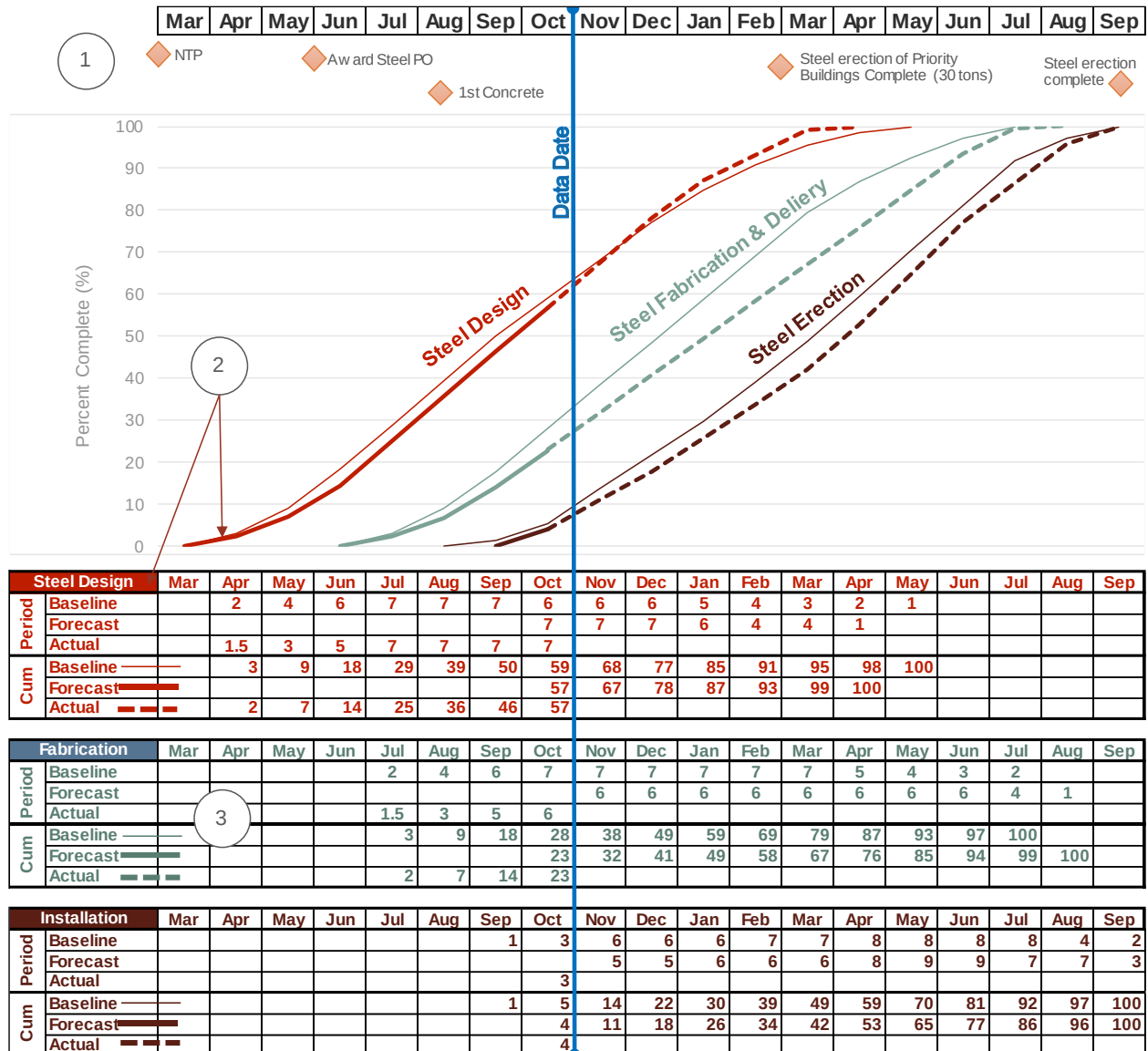
6.6 Additional Information on Curves

It is important that the curves are shown in context of the project contractual milestones, intermediate milestones, or any other event or commitments of significance. This allows for initial validation of the curves, and to focus the team's attention on these events.

Because these curves shall be managed on spreadsheets or similar software, comments and highlights can easily be added to focus the teams attention. Examples include: explanation of delays and mitigation actions, warnings, installation rate information, schedule contingency information, or any other aspect the Lead Planner might want to draw team's attention to.



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Notes:

- (1) Milestones
- (2) Color association
- (3) Period values shown on table only, not to congest the graph area.

6.7 Schedule Curve Analysis

6.7.1 Ramp-up, sustained, and ramp-down periods. The "S-Curve".

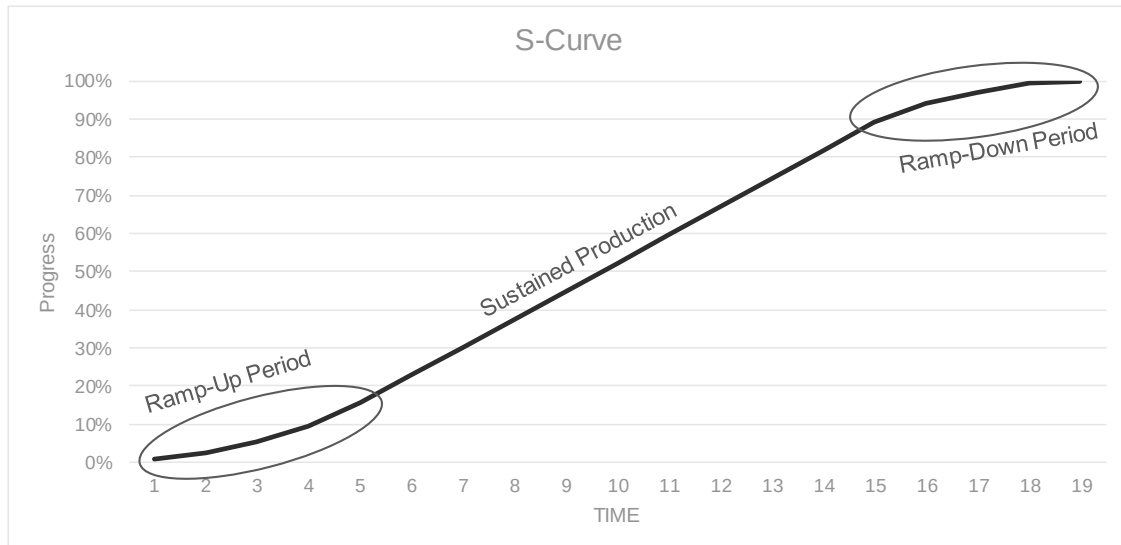
Curves need to clearly convey the ramp-up, sustained production and ramp down requirements for all commodities of the project. Together these form the "S-Curve" curves. Sustained rate is the period when optimum production occurs and can be assumed as being the period between 10% to 90% complete for any commodity.

It needs to be understood that a schedule does not have a unique set of dates. It always provides a range of dates by specifying the early date and late date boundaries within which activities can be executed. Once these early and late dates are established, it is the purpose of the control curve to provide a single progress target for the project to strive to, manually generated at 1/3 of the early curve, and 2/3 of the late curve, and smoothed to provide even staffing requirements for each trade, including realistic ramp-up and ramp-down periods.

On this basis, all commodity and progress curves will tend to form an S-Curve.



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6.8 Required Commodities to be tracked by projects for Expro purposes

Following commodities are to be tracked by all projects under the Expro umbrella in order to generate Expro level commodity curves:

- Earthmoving (excavation and backfill, not temporary storage or material conditioning)
- Concrete (except lean)
- Steel (heavy and medium heavy)
- Piping (excluding small bore)
- Pipeline
- Raceways (Tray & Conduit)
- Cable (Electrical and Instrumentation, measured in meters of cores)

Other commodities shall be added at the Entity's or Projects direction if deemed representative of the project's scope of work.

7.0 ATTACHMENTS

N/A