

WHITE PAPER / **STARTUP AND COMMISSIONING STRATEGIES**

FINISH STRONG: AVOIDING COST AND SCHEDULE OVERRUNS IN LATE-STAGE CONSTRUCTION

BY **Matt Kram** AND **Dan May**

While large construction projects are uniquely complex, the overall goal is simple: Build safe, efficient and reliable facilities on time and on budget. Avoiding speed bumps to achieving these goals can be difficult.



As large-scale construction projects, such as power plants, oil and gas facilities, and large manufacturing facilities, close in on completion, getting to the finish line can feel like an obstacle course. Processes continue to become more difficult with growing on-site teams, scope creep and schedule slipping. But to win any race, proper preparation and planning before the start can mean the difference between a strong finish or a disappointing result.

Successful turnover of a large-scale power plant project is realized by focusing on the startup and commissioning from the outset and deploying the right technology to manage activities.

A SYSTEMS APPROACH TO PROJECT SUCCESS

Whether a plant uses a gas-fired aeroderivative simple-cycle or an advanced gas turbine combined-cycle, it will use thousands of unique electrical and mechanical components. Coupled with the many personnel and disciplines required to construct a plant — and the need to get them online faster — large power projects are naturally complex.

As commissioning and turnover dates draw near, many large projects can run over budget and late on schedule. Crowded workfronts on project sites, colliding schedule timelines and expectations for speedy completion compound an already challenging project environment.

The key to achieving success in complex construction projects rests with viewing the plant as many smaller operating systems. Using a systems approach to planning then helps project teams understand the completion of individual systems to reach each critical commissioning milestone.

It is critical for the project engineering and construction teams to buy into the overall system commissioning plan. Development of the initial commissioning plan sets project procurement deliverables, major construction award dates and individual system turnover scope. The plan needs to be coordinated with the construction, engineering and procurement teams, and must align with the construction plan to build the power plant.

The commissioning schedule and system turnover plan is just the first step in creating a successful project. Managing the project to achieve each of the hundreds of small milestones then becomes the primary challenge.

In the past, reporting on actual project completion progress has been a challenge due to the reliance on inaccurate completion metrics and overpromised early construction progress. Inaccurate time projections and working hours to finish the construction activities have also contributed to the problem. Incorporating effective technology to track the commissioning and turnover process helps minimize and mitigate these issues.

PROJECT PLAN DESIGN

The design phase focuses on each process system, building structure or electrical system of a project.

In upfront Level 1 project planning, startup and commissioning should be considered as an integral part when defining and incorporating project components. Including startup and commissioning development at the onset of planning provides critical late-stage tasks planned early to identify and coordinate requirements, potential challenges and areas of possible inefficiency.

Commissioning professionals must be engaged during the engineering phase, developing the scope of turnover documentation, working with design professionals to develop the flushing plans, testing plans and detailed component lists that make up each system to accomplish those plans. Commissioning professionals should also be reviewing the process piping isometric diagrams, and one-line and three-line diagrams, to confirm the pipe routing. Electrical configuration will allow efficient flushing and testing.

Incorporating planning for commissioning during the early planning phase of the project greatly improves the potential for successful turnover.

PROJECT PROCUREMENT

Procurement professionals work with the engineers to specify, design and schedule all major equipment required for a project. Construction professionals must then work with procurement to sequence the delivery of equipment to coincide with plant construction to allow for efficient construction activities.

BURNS & McDONNELL PROJECT MANAGEMENT TOOLS

For the monitoring and management of quality assurance, quality control, turnover and commissioning execution for some of the most complex projects around the world, technologies that use databases to track all components and aspects of a project are proving successful. Such tools afford benefits that include:

- **Detailed Inspection and Test Records (ITR):** Tracking with QR-coded paper forms or a mobile-friendly application of all quality assurance/quality control and commissioning records.
- **Punch list:** Tracking of deficiencies for all phases of the project, from construction turnover to final facility turnover to the client.
- **Preservation and Maintenance:** Tracking of weekly preservation and maintenance of all equipment on-site, from receipt of equipment to installation and operation.
- **Turnover Package Tracking:** Detailed scheduling and real-time tracking of package walkdowns, contractor turnover dates, release to startup, and commissioning completion and turnover.
- **Digital Turnover Books:** Instant turnover book creation of all construction turnover and commissioning documentation.
- **Key Performance Indicator Reporting:** Real-time information to show the progress of all turnover system activities, including remaining test records, input-output (I/O) loop checks, cable testing, outstanding punch list items, walkdowns and more.

At the start of project planning, the concept of incorporating commissioning and turnover into procurement requirements must be instilled. When it comes to skidded equipment and materials, it is essential to take the time to identify what is needed and when, and to define the detailed requirements involved.

However, procurement can only be successful in contributing to overall project efficiency if the correct equipment requirements are specified upfront. For example, valves should be indicated to arrive with hydrotest trim, with optional trim for flushing, before the operational trim is installed. Determining the components to be delivered with the correct configuration for the proper activity sequence is critical to maintaining efficiency during the final stages of construction and pre-commissioning. Delays of this type invariably have a cascading effect on the project and are avoidable. Improper planning creates schedule disruptions and increases cost.

Factory inspection visits should be incorporated into the procurement plan to verify factory tests are meeting the design requirements of the vendor-provided equipment. Vendors will often modify piping connections points, junction box terminations or other components on the skids. If the items are not inspected at the factory, these issues get passed down to the field engineers and often require rework of the field piping or the reissuing of electrical termination drawings. Such delays create construction rework and result in construction personnel moving off completion of an item while waiting for engineering redesign.

Reducing field engineering and construction rework — through accurate procurement specifications and requirements — greatly improves the cost and schedule, allowing the project to move from construction to commissioning on time.

PROJECT SCHEDULE

Detailed engineering, procurement, construction and commissioning schedules are key to developing the overall project plan. Creation of the detailed commissioning schedule often is delayed until the commissioning manager is on-site; however,

at this point, it is often too late to adjust or modify other aspects of the program to make a significant change in the overall schedule.

Integration and coordination of commissioning activities in the project schedule is essential.

Construction personnel should communicate changes in as-built documents and schedules to allow for the commissioning professionals to be aware of any flow path or scope changes. Construction personnel may be able to re-sequence the construction work to allow for a critical commissioning task, but proper schedule projections, as they occur, reduce idle time, control commissioning cost and keep efforts on schedule. In other words, all phases of the project must work together.

The commissioning schedule should define the construction turnover dates for each process system or partial process system. Scheduling system turnover packages allow the commissioning team to complete early commissioning for utilities and electrical systems while the construction team completes construction of the remaining major components. These parallel activities shorten the overall schedule but also result in additional challenges that must be addressed through planning and coordination between construction and commissioning.

To create the most efficiency, project schedules will typically program construction at the outset of a project. However, agile scheduling should strive to shift from scheduling construction by area to instead scheduling by system toward the end of the construction project phase.



PROJECT CONTROL WITH THE RIGHT TECHNOLOGY

Upfront engineering work and planning that incorporates startup and commissioning sets up a power plant construction project for successful startup, commissioning and turnover. However, planning alone does not control the sheer number of variables that make a power plant project so complicated. The right technology tools are needed to monitor and manage the construction and commissioning process.

Each system turnover package should be tracked, along with each component within each system turnover package. The quality assurance and quality control (QA/QC) documents that verify the construction and installation associated with each piece of equipment can be easily tracked by software, as well as each commissioning test, flush verification and wiring and I/O checkout completed. By using the right commissioning

management software, complex projects can be constructed and commissioned on schedule.

An integrated project management tool can streamline commissioning and turnover activities, monitor QA/QC, help make real-time decisions, track every aspect of project execution, and serve as a monitor for the on-site delivery of materials and equipment through final testing and completion.

Construction commissioning tracking technology should be selected based on its ability to handle all engineering and planning information and specifications, serve as a database of every component installed along with its requirements and testing, and serve as an online and mobile checklist. Construction and commissioning management software must: manage the number of tasks and specific tasks required for quality, assurance and control, and commissioning functional testing; monitor preservation maintenance; provide performance indicator reporting; and serve as a live database to monitor every activity at any given time.

Best-in-class technology that can handle the intricacies of large project management thrives in a complex environment like power plant construction and helps create control to avoid late-stage challenges.

CONCLUSION

By proactively focusing on startup and commissioning at the outset and leveraging completions while utilizing tracking technology, plant construction projects avoid late-stage complexities that otherwise could quickly drive plans off course and unnecessarily increase the risk of cost overruns and schedule delays.

BIOGRAPHIES

MATT KRAM is a construction project manager in the Construction/Design-Build Group at Burns & McDonnell. With more than 10 years of experience in the power generation industry, Matt has worked on several projects that demonstrate his ability to manage power plant construction, startup and commissioning, estimating, cost engineering, quality management, and client relationships. In his current role, he utilizes his strong program and project management skills to deliver success for clients.

DAN MAY is a commissioning coordinator in the Energy Group at Burns & McDonnell. His experience ranges from leading design implementation of emerging technologies to working in the field as the startup and commissioning manager on large power plant projects. With more than 20 years of working on coal- and gas-fired power plants, Dan is passionate about turning over projects to clients that meet and exceed cost and schedule expectations.

ABOUT BURNS & McDONNELL



Burns & McDonnell is a family of companies bringing together an unmatched team of engineers, construction professionals, architects, planners, technologists and scientists to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities with offices, globally. Founded in 1898, Burns & McDonnell is a 100% employee-owned company and proud to be on *Fortune's* list of 100 Best Companies to Work For. For more information, visit burnsmcd.com.