The Commissioning Process: A Step-by-Step Guide

by Paul Turner | Jun 15, 2020 | CSU | 12 comments

Commissioning process helps to achieve the project goals. Have you ever wondered how large complex projects are commissioned and started up? There is a lot that goes on behind the scenes! Each proj have a unique plan to achieve the desired outcome. However, the overall process to plan, commission,

and startup a project is similar in each case. Let's review the steps for commissioning and startup. *For additional information, you can also check this article out to help you set your projects up on success* Project Mindset Lifecycle

Step 1 – Planning

There are several activities that take place off-site prior to the commissioning team mobilizing to site during the design and construction phases of a project. During design and construction, the schedule and sequence of activities during commissioning are used to define the required construction milestones, in order to plan the project schedule. The construction milestones then define the required design milestones. From this sequence of milestones, the project team is then aware of what activities need to be compete and by when to ensure all the project components come together as a final system for testing.

The commissioning team is defined during the design/construction phase, to determine the core members of the commissioning team as well as the support resources required from elsewhere on the project. An important group to ensure are part of the commissioning team is the Owner's operations team, as commissioning activities are the best opportunity for the Ops team to learn about the systems and become familiar with the new operating requirements prior to taking over the systems. Other members of the commissioning team are the electrical/mechanical/automation key discipline leads, consultant subject matter experts (SME), contractors, vendor reps, and owner's reps. *Roles and Responsibilities of the people who are involved in commissioning is one of the lessons in our courses, check it out here* Electrical Commissioning Training Course and Mechanical Commissioning Training Course

Commissioning documentation is defined and prepared in advance of the commissioning phase. This includes the test plans and test procedures to be executed during commissioning, and checklists required, as well as drawings. It is critical that the construction team deliver an accurate set of red-line drawings to the commissioning team in order that the correct installed configuration of equipment in the field is accurately documented.

As construction is completed and equipment installation is complete, the construction and commissioning teams will perform a walkthrough to identify any contract deviations or deficiencies, and list all items on a deficiency tracking list. Deficiencies are then classified as Type-A, Type-B, or Type-B, identifying when each must be complete. Type-A is a showstopper, and must be complete before proceeding to the next activity. Type-B does not need to be addressed immediately and does not impact subsequent activities, but must be rectified prior to handover to the owner. Type-C deficiencies are minor defects and are agreed by the owner to be rectified after handover to the owner.

Contractor document deliverables are defined, such as O&M manuals and training plans, to be delivered during the commissioning phase.

Any specialized test equipment or special tools are defined and procured prior to commissioning. If the constructor is required to provide any specialized equipment, this is defined as well.

Methods to gather test results need to be determined, either as data logging systems or manually recorded. Often there is a significant amount of information produced during commissioning, and a plan to gather, analyze, and report on the test results needs to be determined.

ect will need to be informed on the commissioning progress, what is going well, and any issues

encountered. What information needs to be conveyed and to who should be agreed to by all stakeholders prior to the start of commissioning.

And last but not least, safety management systems need to be established prior to commencing any commissioning activities, *learn more about safety here* Safety During Commissioning. The energy isolation procedures, also known as Lock Out Tag Out (LOTO) process, needs to be established and points of contact identified as responsible for the process.

Step 2 – Factory Acceptance Testing

During the design and procurement phase of the project, a critical step prior to equipment delivery to site is Factory Acceptance Testing (FAT). FAT verifies that the equipment is designed per specification before leaving the factory, where any issues discovered are much easier and cheaper to fix, rather than delaying testing until equipment is installed on-site.

FAT can consist of hardware verification such as dielectric testing of major equipment, or panel wiring of any control cabinets. FAT can also consist of integrated testing, where automation or protection/control logic is loaded into the hardware and verified for correct design and functionality. If this is specified in the contract, then this must be done before the equipment leaves the factory. Because field devices and wiring do not exist in the factory bench testing, interfaces will need to be simulated. Integrated FAT is the most thorough verification, and reduces schedule risk, in order that any errors are discovered prior to site testing. But this requires that the automation design be completed in advance. It is important during the procurement that schedules be planned to allow sufficient time for this to take place, as often the panel wiring and field device designs are not completed, and logic is difficult to

dware design. However, thorough FAT

ll a missioning go much better if it is

known in advance that the hardware delivered to site already works with the logic design.

Step 3 – Mechanical Completion

Mechanical completion occurs at the end of construction once equipment is installed. There is often a formal handover process with forms required to be signed confirming that equipment is installed per the design. The construction team and commissioning team will perform a walkthrough to inspect the installation and confirm there are no deficiencies. Any deficiencies are noted and added to the deficiency list, with associated classification. Confirmation of basic installation is confirmed, such as valves installed in the correct direction, and all wiring point-to-point checks and megger tests have been completed. P&ID drawings are traced in the field to ensure all air/oil/water auxiliaries are available. The construction team will verify that drawings are marked up (red-green drawings) to indicate the as-installed condition, and mechanical completion is the point in time when the red-line drawings are delivered to the commissioning team.

At each mechanical completion, a deficiency list is generated and any Type-A deficiencies rectified before moving into the pre-commissioning phase.

Commissioning Process – Step 4 – On-Site Commissioning

Upon mechanical completion of each portion of the work, and deficiencies agreed to, pre-commissioning activities can then commence.

For mechanical systems, pre-commissioning activities consist of cleaning and flushing of pipes, pressure testing, and leak testing. Any rotating equipment such as a pump are bump tested, which means rotating for the first time on site to verify current draw, pressure, and flow rates. There may be an initial run-in period of motors and pumps to verify vibration and heating/cooling as well as confirm no infant mortality issues.

For electrical systems, pre-commissioning activities consist of panel energization, communication checks, loop checks (internal and external), and verification of any wiring to the central control room if required.

More detailed electrical checks of automation or control/protection circuit may be required, to confirm that any minor updates since FAT are uploaded to equipment, and that the correct protection settings are applied to protection devices. Current injections are done on any current transformers to verify correct polarity and calibration prior to applying primary power to major equipment. Pre-commissioning checklists are completed for each piece of equipment, and may be witnessed by consultant SME to verify tasks are being completed

As each equipment pre-commissioning is complete, new deficiencies are added to the deficiency list (existing from FAT or mechanical completion walkthrough), categorized, and all Type-A deficiencies rectified.

Following completion of pre-commissioning checklists, commissioning can begin. Commissioning is the on-site process to verify that equipment has not been damaged during shipping since the FAT was completed. All field devices are installed at this point, so field wiring is confirmed to be correct, and a subset of FAT tests are repeated to ensure the equipment can communicate to all field devices and that equipment is calibrated.

Mechanical commissioning consists of dry commissioning and wet commissioning. Dry commissioning confirms proper function of mechanical systems without process fluids, while wet commissioning adds the process fluids and chemicals to confirm operation.

Electrical commissioning consists first of pre-energization safety. When equipment is first energized as a system, it may be that construction is still taking place next to equipment currently under test, and it must be ensured that power is safely isolated from any equipment installations. Once isolations are confirmed, equipment racks are powered up and system integration can occur. The field devices are verified to be correctly reflected on HMI screens, and that control of field devices can be done from the central control location. End-to-end communications are verified as accurate and reliable.

Once all mechanical and electrical components are complete, system commissioning can begin, where all the electrical and mechanical equipment works together as a system for the first time. Auxiliary systems are brought online followed by major pa e verified for all equipment. It is now at able and ready for startup of the plant processes. Commissioning checklists are completed and witnessed

by consultant SMEs. Similar to previous stages, the deficiency list is updated with any newly discovered deficiencies, and all Type-A deficiencies are rectified prior to moving to the next steps.

Commissioning Process – Step 5 – Process/System Startup

At this stage, the plant process can now be started. This could consist of a power transmission system, boilogical nutrient removal system, or any other industrial plant manufacturing or specialized system.

Mechanical process are slowly started, and piping is configured for the initial operating scenarios. Flows are started and monitored to ensure correct operation.

Electrical interfaces are verified and power is slowly ramped up to operating levels.

Automation is executed and fault scenarios are tested and verified. *Read this article to learn more about automation, watch the discussion video and learn from Question and Answer portion* The Correct Way to Commission Automation Systems

The equipment undergoes analysis at each stage to ensure the plant process is operating as specified. The Consultant SME and Owner reps are present to verify correct operation of the plant process. The plant is not up and running and functioning as a system – ready for fine-tuning to optimize the process.

Commissioning Process – Step 6 – Performance Verification

Any fine tuning of the plant process operation is conducted by the commissioning team with consultation with the consultant SME and

the contract may require a trial period

pected to operate uninterrupted for a

period of time. This could be 24 hours or 30 days for example, dependent on the contract requirements. Should the system operation be interrupted, the trial period starts over. Once the trial period is completed successfully, the Provisional Acceptance Certificate (PAC) is issued to the contractor. The contract may also specify a performance guarantee period, where the plant processes are expected to meet certain contractual criteria over a period of time. The performance guarantee period may have commercial impacts dependent on the performance achieved. Once the performance guarantee period is complete and commercial impacts have been determined, the Final Acceptance Certificate (FAC) is issued to the contractor.

Commissioning Process – Step 7 – Operational Readiness

As the project approaches the in-service date, it is beneficial to the owner to prepare the operations team for eventual handover and operation of the new systems. In fact, it is best to have the owner's operations staff involved in the commissioning process, as this is a great time for them to learn about the new systems and ask the experts who are on-site testing the systems any questions that they have. The operations staff have a vested interest in the operation and maintenance of the systems, and are often the best to manage any document management systems or setup of asset management systems. A soft handover approach is best to prepare operators as opposed to waiting to the end of the project, passing a bunch of new information to operators, and the project team leaving site. Please check this article to learn more about Operational Readiness

Training is a key deliverable for the operating individuals to obtain from the project. Contracts will typically define the training that the contractor is required to provide. Training sessions should be

ning activities in order that operators have some experience with the new systems prior to being asked to

work with the new systems. *Please feel free to check our in-depth training here* Electrical Commissioning Training Course *and* Mechanical Commissioning Training Course

The owner will typically have an established asset management system. If this is a first new system for the owner, an asset management system may be a new system being established. The asset management system contains information on each asset, the hierarchy of installation, nameplate data for each, preventative maintenance requirements, and warranty information. The warranty period may require more specific maintenance requirements in order to maintain warranty, and this needs to be implemented in the asset management system for future demonstration of compliance to maintenance requirements to the contractor. The asset management information is contained within a software package that generates work orders for required maintenance tasks and records of completed tasks. The project team may be responsible to provide the information package containing all asset information to be loaded into the asset management system for continued use by the operating team.

The warranty period begins once each piece of equipment is placed in service, or at issuance of PAC, dependent on the contract requirements. The warranty period typically lasts from PAC to FAC, and can be one, two, or five years, dependent on contract requirements. Some equipment may have extended warranty, such as battery systems, or others, than extend longer than the project warranty duration. The warranty period is when any Type-C deficiencies are rectified by the contractor. As well, processes are required for the owner to request any changes or service to the system, as the contractor must be involved in any changes to the system to ensure the warranty is not voided by unknown changes.

Once FAC is issued, the project officially comes to a close. If designed, installed, and commissioned well, the assets should last for many years into the future.

As you can see, there is a lot involved in commissioning and starting up an industrial plant. It can be a complex initiative, but is the best part of the project as you get to see the original design come to life! If the above steps are applied to each project, complex projects can be broken down and these industry best practices applied at each step. Even though each project is different, these above steps can be applied with the unique aspects of each project incorporated into each step. The commissioning process does not have to be overwhelming when approached using the above steps.

Thanks, and good luck in your commissioning career!

Paul Turner, P. Eng, PMP

12 Comments

1.

Gokulakrishnan Ramachandran on June 17, 2020 at 10:24 am
Hi Paul,
This is what exacrly we follow in our projects.
Regards,
Gokul

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- 

  Paul on June 17, 2020 at 10:45 am
  Great to hear, thanks for the feedback!

  Loading...

2.

DING WUHONG on June 17, 2020 at 10:39 am
Paul,

I really appreciated you for the three days' course. I can understand the commissioning process much better now. I worked as a commissioning engineer for several projects, including an offshore platform, a few petrochemical plants, and an LNG terminal. each project is unique and has different problems to face and to be solved. but one thing in common, happiness always comes after the [illegible] the project. so I love this job. thank u.

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  Paul on June 17, 2020 at 10:46 am
  I'm glad you enjoyed my 3-day mini-course and hope it can help you in your career!

  Loading...

3. 

Bimbo Pao Relegano on June 18, 2020 at 2:24 am
Hi Mr. Paul,

Thanks again for the commissioning process guidance that you share with us, it's very interesting and I like it.

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  Paul on June 18, 2020 at 5:50 am
  Thanks Bimbo, happy to help!

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4. 

Chaouchi Foudhil on June 19, 2020 at 12:05 pm
Dear Sir;

Thank you for this a small trainig its helful thank you again sir

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  P 12:32 pm
  H ı enjoyed the course, happy to help!

  Loading...

5.

Rafael Luis Araoz Miranda on July 2, 2020 at 7:03 pm
Excellent, Thank you very much for the information and guidance of the start-up process.

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  Paul on July 2, 2020 at 10:16 pm
  I'm glad you find the information helpful!

  Loading...

6.

Waqas Suleman on July 11, 2020 at 12:36 am
Paul,

This course can really helpful for beginner in Commissioning field. Everything explained in brief manner.

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- 

  Paul on July 11, 2020 at 7:51 am
  I'm glad you found the course helpful!

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