

<p style="text-align: center;">KLM Technology Group</p> <p style="text-align: center;">Practical Engineering Guidelines for Processing Plant Solutions</p>		<p style="text-align: right;">Page 1 of 15</p> <p style="text-align: right;">Rev 3.0</p>
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Roles and Responsibilities of Plant Pre-Commissioning, Commissioning and Acceptance Test Run

Introduction

There are many parts of a grass root or revamp plant construction. They include

1. Basic Process Engineering
2. Detailed Engineering
3. Procurement
5. Construction
6. Operations Training
7. Mechanical Completion
8. Pre Commissioning
9. Commissioning
10. Acceptance Test Run.

The construction is considered complete with the signing of the “mechanical completion”. Operations Training should be completed as the plant is being constructed. This is typically done by the technology licensee. Additional courses such as Project Management, Hazard Identification and Safe Unit Commissioning can be provided by KLM Technology Group as “in house training” or in regional conferences.

Then the pre commissioning and commissioning commences, which can be done in phases as the construction is completed. Commissioning is a verification process used to confirm that a facility has been designed, procured, fabricated, installed, tested, and prepared for operation in accordance with design drawings and specifications.

Typically commissioning packages (details of how the commissioning is to be carried out) are planned and completed. The trained operators execute the commissioning as a second phase of their training. This gives them plant experience and ownership.

At the completion of pre-commissioning, commissioning is planned and commenced. “On Specification” products should be made within a reasonable period of time, after which an Acceptance Test Run is planned and commenced.

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Plant operations personnel are employed by the Operations Company and will follow the construction, do the pre-commissioning, commissioning, and acceptance test run. External Advisors are employed by the operating company, construction company, and the technology licensee to provide advice and assistance to the operations personnel. In most countries only the personnel employed by the Operations Company may actually operate the equipment for safety, liability, and insurance requirements. KLM Technology Group can provide experienced personnel for the operations, advice and assistance.

A successful plant commission has at least four parts, which out which one cannot be considered a success.

1. No Loss Time Accidents. No commissioning can be considered a success if it is not done safely. Safety has to be stressed from the very beginning of the design, construction and commissioning.
2. No Equipment Damage. This function of many disciplines, design, construction operations and commissioning team.
3. On Test Product within a reasonable period. Less than two days would be considered very good, seven days would be acceptable, and above fourteen days would be less than acceptable.
4. No Environmental Incidents. Again this is a function of many disciplines. The environmental impact can be reduced by successfully making on test product within a reasonable period.

It is important to start the project with these goals. Select a good team, train them well, and give them the tools to succeed.

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Health, Safety and Environmental

A Health, Safety, and Environmental (HSE) Management Plan should be developed for the project. In addition, other plans and procedures to cover the inherent risks associated with pre-commissioning, commissioning, and other activities as well as risks associated with the performance of these activities while others are working in adjacent areas of the facility.

These plans / procedures may consist of, but are not limited to:

1. Identification of systems under the control of commissioning
2. Pre Start-up Safety Reviews (PSSRs)
3. Permit to Work system
4. Hazard identification and risk management
5. Simultaneous Operations (SIMOPS)

Of particular concern are facilities with multiple train / process units where construction and commissioning activities may be occurring in one area of the facility simultaneously with start-up and operations (by the Client) in another area.

Operations Training

The objective of operations training is to instruct the operators to safely commission and to make on specification production while reducing environmental impact. This is typically includes several weeks of training and many times with a similar plant site visit. Good training may be expensive, but no or bad training is even more expensive.

Step to ensure the operators are properly trained:

- Ensure the start up and commissioning procedures are reviewed and understood by the operators by written test. Strive to have all procedures be comprehensive, yet easily understood.
- Help the operators learn through experience.
- Teach them to not just to walk through a poor procedure, work with your supervision to get it improved and updated.

- Teach them to always keep the importance of routine jobs in perspective. Don't let their routine nature diminish their role. Routine jobs such as vibration and corrosion inspection can help to detect problems early and prevent a serious incident.

The local staff needs general instruction in the following fields;

1. Safety
2. Hazard analysis
3. Furnaces,
4. Boilers and Steam Systems,
5. Steam Turbines, Pumps, and Compressors,
6. Distillation,
7. Piping and Heat Exchangers,
8. Process Control Systems,
9. Electrical Systems,
10. Catalyst and Molecular Sieve Systems,
11. Cooling Water Systems and Treatment,
12. Process Utilities
13. Relief Valve and Flare Systems
14. Environmental Reduction

If the local staff has some operations experience this can be covered quickly, but with limited operations experience the fundamentals need to be understood to optimized and received the full benefit from the plant investment. With experienced operations staff this can be completed in 15 to 20 days.

One typical way to complete the operations training is called "train the trainer". A selected group of the engineers and experienced operations personnel is given training by the senior commissioning manager. Then these trainers train the local staff.

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Specific Plant Training for the “Train the Trainer” Group would include;

1. Pre Commissioning Procedures
2. Commissioning Procedures
3. Plant Specific P&ID Review
 - A. Tower Review
 - B. Reactor Review
 - C. Process Control Review
4. Distillation Overview
5. Plant Specific Process Variables
6. Normal Start Up and Shut Down Procedures
7. Emergency Shut Down Procedures
8. Plant Specific Environmental Concerns

The “Train the Trainer” should be completed in 10 days, and then followed by 20 to 30 days training of the local staffing by the trainers. KLM can provide Senior Commissioning Managers to provide training.

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Mechanical Completion

A plant, unit, or facility, or any part thereof, is considered Mechanically Complete (MC) when it has been erected in accordance with applicable drawings and specifications. The definition of MC varies from project to project depending on contractual requirements.

Mechanical Completion activities consist of all non-operating activities. A typical list might be as follows;

Mechanical Completion Items	Constructor	Operations	Advisors
1. Installation of piping and equipment	Perform	Witness	
2. Integrity (hydrostatic/pneumatic) testing	Perform	Witness	Witness
3. Equipment Inspection (Towers, Reactors, ect)	Perform	Witness	Witness
4. Develop Punch List		Perform	Witness
5. Cold alignment checks	Perform	Witness	Witness
6. Point to Point continuity checks	Perform	Witness	Witness
7. Removal of free water from systems		Perform	Witness
8. Preservation and maintenance		Perform	Witness

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Punch list

Punch listing is an integral part of the mechanic completion process and is a critical step to verifying the status of systems completion. The category of a punch list item determines if a system is ready to move into the next phase of commissioning. Punch list items are prioritized into one of three categories; type A, B, or C.

Category A

Type A punch list items are deficiencies or pending work that must be repaired or completed prior to issuance of a Mechanical Completion

Category B

Type B punch list items are deficiencies or pending work that may be cleared after declaration of Mechanical Completion but must be closed out in pre-commissioning.

Category C

Type C punch list items are deficiencies that must be cleared prior to commissioning. These are items that are required to be corrected prior to proceeding with a safe start-up and continuing operations.

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System Turn Over

A turnover procedure and schedule for the project should be developed. The turnover procedure and schedule will define how the systems are turned over from Construction to Commissioning; what work has to be completed, and by whom, before a system can be turned over; and when systems need to be turned over. Development and agreement of these procedures and schedules ensures the efficient turnover of systems, safe execution of concurrent activities, and ultimately earlier start-up.

Typically, Utilities and OSBL (Out Side the Battery Limits) are scheduled first, followed by the process areas - ISBL (Inside the Battery Limits)

The Commissioning Team will prepare systems definitions as early as practical in the project. Prioritized systems definitions form the baseline for planning and executing projects. A preliminary list of turnover systems will be developed during the Front End Engineering Design (FEED). This is generally done by highlighting a set of Process Flow Diagrams (PFDs) and Utility Flow Diagrams (UFDs).

During detailed engineering a more detailed set of systems definitions will be developed by highlighting P&IDs and other engineering documents as appropriate. Each system will be assigned a descriptive name and number. The name and number should follow the same process unit numbering convention used by Engineering.

Prioritized systems definitions will be loaded into a management system. Planning for this data should start during the FEED. The actual upload of information into the management system will take place as early as practical during the detailed engineering phase of the project.

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Pre Commissioning

Pre-commissioning, also referred to as static commissioning, starts when a system or sub-system achieves Mechanical Completion. The safety monitoring activities will change at this transition as fluids (water, air, nitrogen, hydrocarbons, etc.) are introduced into sections of the facility to support testing, cleaning, flushing, and other pre-commissioning activities.

Pre-Commissioning activities are items that are done following Mechanical Completion. Attached is a typical list of Pre-Commissioning Items

Pre-Commissioning Items	Constructor	Operations	Advisors
1. Temporary Screens, Strainers and Blinds		Perform	Witness
2. Air and Steam Blowing		Perform	Witness
3. Flushing, Chemical and Mechanical Cleaning		Perform	Witness
4. Cleaning and Passivation		Perform	Witness
5. Electrical System Energizing		Perform	Witness
6. Instrumentation Verification		Perform	Witness

Commissioning

Commissioning is a verification process used to confirm that a facility has been designed, procured, fabricated, installed, tested, and prepared for operation in accordance with design drawings and specifications.

Commissioning Items	Constructor	Operations	Advisors
1. Operational Tightness Testing		Perform	Witness
2. Oil Systems Flushing		Perform	Witness
3. Loading of desiccants and catalysts		Perform	Witness
4. Refractory dry out		Perform	Witness
5. Run in of rotating equipment		Perform	Witness
6. Drying Out and inerting		Perform	Witness
7. Instrument and electrical function testing		Perform	Witness
8. Function testing of safety systems		Perform	Witness

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Pre Start-Up Safety Review

A Pre-Start-up Safety Review (PSSR) will be conducted prior to start-up. A designated team led by the Client and consisting of Client and Commissioning personnel will jointly conduct the PSSR once construction is essentially complete and prior to start-up of any system. The PSSR plans and procedures will be developed by the Client.

The PSSR review shall confirm that, prior to the introduction of highly hazardous chemicals to a process:

- 1) Construction and equipment is in accordance with design specifications.
- 2) Safety, operating, maintenance, and emergency procedures are in place and are adequate. All safety systems are functioning properly.
- 3) A process hazard analysis has been performed and recommendations have been resolved or implemented before start-up.

Hydrocarbon Introduction

If the plant is a hydrocarbon facility, a detailed procedure of how to introduce hydrocarbons to the plant should be developed. The procedure should be completed by the operations group with guidance from the advisors.

KLM can typically provide one Commissioning Manager, two on shift operations specialist (working 12 hours shifts) and one Acceptance Test Run (ATR) Engineer to assist and advise in the commissioning for a small unit like a Hydrotreater.

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Acceptance Test Run (ATR)

The Acceptance Test Run will be held after commissioning and hydrocarbon introduction. An approved Acceptance Test Run procedure will be developed and utilized.

Advisors

The team of Advisors will include three categories;

1. Commissioning Manager
2. Commissioning Engineer
3. Commissioning Operator Specialist

Commissioning Manager

The Commissioning Manager typically is a Chemical / Mechanical Engineer with greater than 15 years' operations experience. They will have been through several grass roots start-ups.

Responsibilities;

1. Be a liaison between the operating company and the Technology Licensee. Manage and work toward building a cohesive team for the most successful start up possible. Encourage open communication between all parties in the organization.
2. Attend meeting as required, typically there is a morning meeting to track progress. Answer and give guidance as required.
3. Issue written guidelines for planned task. The operating company can utilize these guidelines to develop the daily orders.
4. Manage the commissioning engineer and operator.
5. Ensure that site processes are monitored and controlled to achieve safe and economical operation while developing all operators to their full potential.

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6. Coach the operators to complete the maximum possible amount of follow-up on their own when items are not as per normal operation. Be an approachable coach to those on your team. Help the operators learn and grow by enthusiastically sharing your knowledge with them and helping them solve problems.
7. Provide technical leadership and expertise to facilitate safe, reliable, and economical operation of the site processes.

Commissioning Engineer

The Commissioning Engineer typically is a Chemical / Mechanical Engineer with some design and operations experience. The Commissioning Engineers contribute to the team by performing a technically oriented service function. They must remember to respect the supervisory role of the operations supervisors and work through them on all issues related to operations.

The Commissioning Engineer will record and track the Acceptance Test Run procedure data and make recommendations where and when adjustments need to be implemented. They can be utilized on shift or on a straight day mode.

Responsibilities;

1. Encourage open communication between all parties in the organization. Communication is essential to the success of any organization. Continually strive to develop a positive relationship with open communication with the operators as well as the Production Supervisor.
2. Record Acceptance Test Run data.
3. Develop recommendations to improve Acceptance Test Run.
4. Ensure that site processes are monitored and controlled to achieve safe and economical operation while developing all operators to their full potential.
5. Coach the operators to complete the maximum possible amount of follow-up on their own when items are not as per normal operation. Be an approachable coach to those on your team. Help the operators learn and grow by enthusiastically sharing your knowledge with them and helping them solve problems.

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6. If on shift;
 - A. At the beginning of each shift exchange information - be inquisitive; fully understand the state of operations, problems, etc.
 - B. Initiate any immediate action needed (recommendations for Maintenance, Operators, etc).
 - C. Review the operation soon after shift change and several times throughout the day.
 - Inside – review board operations and product specifications
 - Outside - review outside route via round sheets immediately after completing each route. This helps to detect trends that may not have been noticed while collecting data.
 - D. At end of shift be sure to effectively verbally communicate to your relief, be sure and record all significant items in the logbook.

Commissioning Operator

The Commissioning Operator typically is operations personnel with greater than 10 years' operations experience. They will have seen several chemical plant grass roots start ups. They must remember to respect the supervisory role of the operations supervisors and work through them on all issues related to operations.

The Commissioning Operator will record and track the Acceptance Test Run procedure data. They are typically utilized on shift mode.

Responsibilities;

1. Encourage open communication between all parties in the organization. Communication is essential to the success of any organization. Continually strive to develop a positive relationship with open communication with the operators as well as the Production Supervisor.

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2. Record Acceptance Test Run data.
3. Ensure that site processes are monitored and controlled to achieve safe and economical operation while developing all operators to their full potential.
4. Coach the operators to complete the maximum possible amount of follow-up on their own when items are not as per normal operation. Be an approachable coach to those on your team. Help the operators learn and grow by enthusiastically sharing your knowledge with them and helping them solve problems.
5. While on shift;
 - A. At the beginning of each shift exchange information - be inquisitive; fully understand the state of operations, problems, etc.
 - B. Initiate any immediate action needed (recommendations for Maintenance, Operators, etc).
 - C. Review the operation soon after shift change and several times throughout the day.

Inside – review board operations and product specifications

Outside - review outside route via round sheets immediately after completing each route. This helps to detect trends that may not have been noticed while collecting data.

- D. At end of shift be sure to effectively verbally communicate to your relief, be sure and record all significant items in the logbook.

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