



NAC Executive Insights

Startup-Driven Design

Key Points

- Startup is more than just turning the plant “on.” It is about tuning the plant to meet or exceed its nameplate ratings.
- A 10 percent overrun in capital expenditures (CAPEX) will cost half what a one percent loss in efficiency might over a 10-year period.
- Delayed startups impact not only traditional privately owned power, process, and industrial facilities, but also infrastructure projects that are financed using public private partnership (PPP) models.
- Efficient startup begins at the very outset of design through the establishment of an expanded basis of design.
- Detailed startup planning and programming starts during the detailed design phase and builds on work that was initiated with an expanded basis of design.

Introduction

On capital projects, the value created by efficient design and construction execution can be quickly destroyed by a delayed or inefficient startup. Time lost during startup is revenue denied. Delayed startup impacts not only traditional privately owned power, process, and industrial facilities, but also affects infrastructure projects financed using public private partnership (PPP) models. Inefficient startup is characterized by delayed startup and by extended capacity ramp-up over what was initially planned.

This Executive Insight focuses on startup-related activities and considerations during the design and construction phases, long before actual startup begins.

Why Successful Startup is Important

Startup is more than just turning the plant “on.” It is about tuning the plant to meet or exceed its nameplate ratings. A typical cash flow analysis will show that a 10 percent overrun in capital expenditures (CAPEX) will cost half what a one percent loss in efficiency might over a 10-year period.

In industries where “time to market” is important, market share losses from delayed startup can be significant. It might even mean the difference between a blockbuster product and a lackluster one.

Keys to Efficient Startup

Efficient startup begins at the very outset of design through the establishment of an expanded basis of design, which brings a sharpened focus to operations and maintenance (O&M) aspects of the project and by extension to many of the systems that must go through a successful startup process. This O&M focus:

- Provides clear acceptance criteria verified during construction, commissioning, and initial operation.
- Informs decisions on equipment selection, layout, installation, operation, maintenance, and replacement until requirements change.
- Delivers a more effective asset management database at startup.
- Improves construction efficiency and effectiveness.
- Enhances construction safety.
- Improves O&M efficiency and effectiveness.
- Supports selection of the best options by considering all life cycle costs.

Designing for Startup

Design aspects considered as part of an expanded basis of design and then further developed during the design process include:

- Plant layout
 - Identify areas and equipment to be accessed for plant startup and ensure safe and efficient access.
 - Laydown areas for temporary equipment associated with plant startup, including ensuring their installation, is consistent with construction sequencing and common final fit-out and punch list activities.
- Hazard elimination
 - Identify changed safety conditions associated with startup activities and eliminate or mitigate new safety hazards.
 - Access points and covers should not have sharp corners, including those where temporary startup equipment may be located.
 - Design should reflect safe access for startups.
 - Provide for “isolation” of equipment during startup:
 - Lockout valves and switches
 - Electrical isolation
 - Safety and software interlocks include startup and commissioning configurations.
- Improved access to workface
 - Required work platforms and equipment laydown or pull areas are to be reflected in design for startup activities.
 - Space provisions for temporary equipment required for startup and accessibility envelope should be clear and understood.

- Equipment
 - Incorporate startup provisions in design development.
 - Reflect startup set-up and staging requirements.
 - Identify typical combinations of startup activities in plant and systems design and layout.
 - Pre-commissioning
 - Incorporation of pre-commissioning isolation valves and electrical lockouts is required.
 - Assurance of accessible temporary attachment points for test equipment.
 - Design for rapid replacement of routine startup items (plug and play; quick-opening fasteners).
 - Systems/subsystems/components should be designed to be functionally, mechanically, electrically, and electronically as independent as practical to facilitate startup and testing.
 - Startup “envelopes” should be reflected in design layouts.
 - Provide flat laydown areas for components removed during startup.
 - Identify temporary provisions for startup (scaffolding, lifts).
 - Identify any crane or other temporary equipment support points and confirm capacity and clearances.
- Consumables
 - Startup often requires initial system fills or other consumables. Recognizing these at the design stage influences procurement specifications as well as inclusion of temporary provisions for water, fuel, or other consumable storage.
- Startup practices and techniques
 - Identify unique startup practices or techniques to be utilized and provided for in design.
- Management processes and practices
 - Build startup documentation from initiation of design.
 - Failure Mode and Effect Analysis (FMEA) and Fault Tree Analysis (FTA) should be included in system and component maintenance documentation and include startup system configurations.
 - Identify all startup assumptions and requirements in design documents and consolidate and track.
 - Conduct an early startup risk assessment utilizing these assumptions.
 - Startup information, including equipment and vendor data, should be required to be directly incorporated in the facility asset model (building information model) or database.

Detailed startup planning and programming starts during the detailed design phase. They build on work that initiated with an expanded basis of design. It includes not only plant startup, but also:

- Pre-commissioning (this may be performed at a fabrication facility, module yard, or vendor facility).
- System cleanout (caustic or acid wash; detergent or other flush; chemical wash).
- Commissioning.
- On-site acceptance testing.
- Performance testing and validation.
- Validation of operating procedures and performance under different operating scenarios (normal, off-normal, part load).

Training requirements and any special personnel required for startup activities are first identified at this time.

Summary

Startup marks the transition from the capital expenditures (CAPEX) phase to the operating expenses (OPEX) phase. It represents not only a significant schedule risk for the plant to transition from a consumer of capital to the generator of a capital return, but also the opportunity to best ensure that anticipated operating performance baselines are met.

While startup activities occur at or near the end of the CAPEX phase, they are initiated at the very outset of the design process. Their planning and requirements are essential elements of design that are implemented through procurement and construction.

The elements to be considered during design to facilitate “vertical” startup contained in this Executive Insight are not intended to be exhaustive but indicative.

For Further Reading – Executive Insights

- Business Basis of Design

About the Author

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