FOAK Planning Considerations, Construction Shiftwork/Productivity, and Modularization

Implementation Guide 04 for NEI 20-08, "Strategic Project Management Lessons Learned & Best Practices for New Nuclear Power Construction"

Executive Summary

Revision 1

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Revision Table

Revision	Description of Changes	Date Modified	Responsible Person
0	Initial Issuance	7/2023	Benjamin Holtzman
1	Document updated to align with subsequent materials and correct any inconsistencies.	11/2025	Benjamin Holtzman

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EXECUTIVE SUMMARY

Adapting best practices and lessons learned[1] is key to predictable project execution, reducing cost and schedule risk, and achieving economic competitiveness for nuclear energy. NEI 20-08, "Strategic Project Management Lessons Learned & Best Practices for New Nuclear Power Construction," identifies 14 areas of construction best practices, with a total of 59 key construction best practices, that have been critical in the successful execution of large complex projects. Implementation guides (IG) are developed to explain how these best practices can be incorporated into new nuclear projects (NNP). The development and construction of nuclear power plants, whether First-of-a-Kind (FOAK) or Nth of a Kind (NOAK) may be subject to longer project schedules and need to account for uncertainty, and FOAK construction has additional elements that add to the overall risk.

The following are the high-level key insights, which provide discussion, guidance and recommendations concerning FOAK risks, construction shiftwork, and benefits and/or drawbacks of modularization. This guide is written primarily from the perspective of internal stakeholders[2] that are directly engaged in the new nuclear power project.

A "First-of-a-Kind" project is defined as the initial project that is materially different in design or deployment method from previous projects, including new technology, materials/components, or design/construction means and methods. FOAK can refer to a full project or key elements that are part of the scope. FOAK project issues and risks must be accounted for from the early planning phases through execution. Projects should factor the actions to resolve FOAK issues into the integrated project schedule and cost estimate with appropriate uncertainty factors. Addressing the risks posed by FOAK requires identifying FOAK and non-FOAK project elements, understanding and applying relevant lessons learned, preparing mitigation strategies, creating appropriate contingency and documenting lessons learned for future projects. More details for risk management can be found in IG 02 *"Organizational Challenges, Collaborative Contracting Strategies, and Aggressive Risk and Opportunity Management"*.

<u>General Forms of FOAK Risk</u>

- FOAK Bias (Dunning-Kruger Effect)
    - Overconfidence and Underestimate Challenges
    - Poor Accounting for Contingencies
    - Learning Curve Trap

[1] While the lessons learned used to develop this guidance come from experience with existing reactors and other sources as noted, this guidance can be applied to SMRs, other advanced reactors, heavy water reactors, micro-reactors, or large light water reactors. All entities using the information in this implementation guide should evaluate these best practices for their own purposes.

[2] For our purposes, a "stakeholder" is any person or group that may be positively or negatively impacted by an NNP project. Stakeholders can be internal (directly or indirectly within the owner/contractor/supplier organization) or external (outside of the project organizations). Section 7.1 of IG #3 provided additional information about identifying stakeholders.

- Types of FOAK (Difference in Scope or Detail than prior experience)
    - New Technology (e.g., New Reactor Design)
    - New Components (e.g., New Pump)
    - New Approaches (e.g., Construction or Assembly Method)
    - New Partners
    - New Licensing Processes
- Workforce Proficiency
    - Lack of Experience in Project Team (e.g., Construction Management)
    - Lack of Recent Nuclear Construction Experience (e.g., Construction Labor)

Managing labor can be one of the most difficult challenges for new nuclear power (NNP) projects, based on the size, complexity and availability of skilled knowledgeable resources. Constructing a nuclear power plant involves careful coordination of trained craft workers on-site over extended periods of time. Craft retention and increasing efficiency should be prime goals for nuclear constructors. New nuclear power projects need to develop work schedules that balance the skills, capability and size of the available labor pool. Understanding lessons learned related to causes of inefficiency and fatigue should inform the labor strategy and shift patterns developed. The overall project schedule and budget should also identify the delivery of offsite modules to match the required erection sequencing.

Based on extensive research coupled with direct construction experience, a combined extended work week (beyond regular hours, i.e., 40hrs) and second shift program should be used prudently, only when necessary, to accelerate the schedule, implement critical path corrective action or alleviate congestion. Excessive use of extended work weeks and extra shifts can lead to loss of productivity and other unintended project costs. New nuclear power projects need to develop work schedules that balance the available labor pool, recognize lessons learned for efficiency and fatigue, and the overall project schedule and budget. A lightly manned second shift can complete clean-up and stage material to ensure the main shift is fully productive on critical path and near critical path tasks.

Reaching NOAK will require achieving benefits from repeatable processes, standardization, and modularization. The design for nuclear plants may consist of a combination of modules and stick-built construction techniques. Modularization has been a focus for most recent technology developers as they finalize their standard plant designs. Standard plant designs including modules and equipment skids constructed offsite can reduce overall completion times and provide significant schedule and economic savings when properly managed. Offsite modular construction in shop conditions can occur in parallel to on-site stick-built field construction activities, reduce labor congestion and improve labor productivity. Deliberate consideration on how modules will be designed, constructed, manufactured, and inspected will improve the success rate of deployment. Standardized designs for NNP projects will also allow for continuous improvement through application of lessons learned and repetitive work tasks.

