Strategic Project Management Lessons Learned & Best Practices for New Nuclear Power Construction

Publicly Available Executive Summary

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Acknowledgements

This document was informed by discussions with various past and recent large project stakeholders (owners, EPC contractors, and original equipment manufacturers), the Department of Energy Office of Nuclear Energy, and other industry players. NEI acknowledges and appreciates the contributions of NEI members and other organizations in providing input, reviewing and commenting on the document.

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Purpose

This report was prepared for the Nuclear Energy Institute (NEI) by High Bridge Associates, Inc. (High Bridge). This was done in collaboration with the NEI Construction Best Practices Task Force to examine historical planning and performance industry information to develop:

- A consolidated report of strategic lessons learned, best practices, and keys for success for planning, organizing, and deploying New Nuclear Power (NNP) projects
- An assessment of blind spots and obstacles to implementing these lessons and practices, and
- Case Studies of past successful NNP projects to provide insights on what strategic measures made a difference

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Executive Summary

Interest in deploying new nuclear reactors in the U.S. is increasing as more stakeholders recognize the critical role that nuclear energy must play in order to reduce carbon emissions. Today, nuclear energy accounts for almost 20% of the U.S. electricity generation, and, when viewed as part of a clean energy portfolio, nuclear energy produces over 50% of the zero-carbon emissions electricity. Nuclear energy is firm dispatchable energy that can operate 24/7, making nuclear, renewables and storage resources the perfect partners to achieve zero to very low carbon emissions.

As utilities establish plans to reduce carbon emissions in order to meet clean energy standards or their own voluntary commitments, many are looking at advanced nuclear reactors as potential options for generation additions. Advanced reactors include light-water cooled small modular reactors (SMRs), non-light-water cooled reactors (non-LWRs), and micro-reactors. These advanced reactors will complement the larger nuclear reactors in operation today and provide new options with their flexibility and lower up-front costs.

One of the major factors for utilities considering new nuclear reactors is the construction risk, as there has been experience in the U.S. where the construction of a new nuclear power plant was over schedule and over budget. There is also relatively little recent construction experience since most of the nuclear reactors in operation were built in the 1970s and 1980s. The industry does have experience building nuclear reactors on-time and on-budget in the U.S. that can be applied to future new nuclear projects.

The Nuclear Energy Institute is working with our members to reduce the risk of future nuclear reactor construction projects and better enable these reactors to be built on-time and on-budget. The approach we are taking is to identify the best practices for nuclear reactor construction, develop the details on how to implement these best practices, and support the implementation of best practices for new nuclear projects. NEI is issuing this report, titled *Strategic Project Management Lessons Learned & Best Practices for New Nuclear Power Construction,* for use by members that are planning for the construction of new nuclear reactor projects.

The purpose of this report is to compile and describe the construction best practices that will reduce construction risk and better enable projects to be built on-time and on-budget. There have been over 100 documents over the past several decades that have identified the lessons learned from past nuclear reactor construction projects. While many of these reports identify similar lessons learned, they also contain lessons that are not identified in other reports. Therefore, we used industry expertise to synthesizes the 32 most relevant documents and establish the top strategic project management lessons learned and best practices that experience shows have been key in the successful execution of large complex projects. Documented in this report are the following fourteen (14) areas of construction best practices required for the successful completion of a new nuclear reactor project. Within these 14 areas, a total of 59 key construction best practices are identified and described.

A. <u>Project Organization, Owner Led Integrated Team, and Best Athlete Approach</u>
   1. Extreme Ownership and Leadership from the Top
   2. Organizational Challenges are Tougher than Technical Issues
   3. Collaborative instead of Confrontational Contracting Strategies
   4. Aggressive Risk and Opportunity Management instead of Risk Shedding Approach
   5. Ingrained Large Nuclear Construction, Quality, and Safety Culture and Mentality

B. First of a Kind (FOAK) Project Parameters and Challenges
   1. Recognizing what FOAK Is
   2. Experience of Stakeholders
   3. Design Maturity and Details Required for Construction
   4. Realistic Cost and Schedule Baselines

C. Project Management Involves Art and Science
   1. Integrated Project Schedule, Owner Control, and Simplified Reporting System
   2. Rigorous Configuration Management and Design Change Control
   3. Labor Efficiency, Extended Workweeks, Shiftwork, and Fatigue
   4. Modularization Potential Benefits and Drawbacks
   5. Managing Project Internal and External Stakeholders

Among these, the need for extreme ownership and leadership from the top was identified as the most important success factor. To model extreme ownership and leadership from the top, industry top leaders offer their personal insights and priorities to reinforce the details discussed within this report.

In addition to describing the key construction best practices, this report also documents case studies of large FOAK projects spanning commercial nuclear power plant construction, nuclear facility decontamination and decommissioning (D&D), municipal infrastructure, and a government science facility that were built on-time and on-budget. These case studies include:

1. River Bend Nuclear Power Station Unit 1
2. St. Lucie Nuclear Power Station Unit 2
3. Palo Verde Nuclear Power Station Units 1, 2, and 3
4. Watts Bar Nuclear Power Station Unit 2
5. Rocky Flats D&D Project
6. Selected Steam Generator Replacement & Refurbishment Projects
7. Spallation Neutron Source (SNS) Accelerator Project
8. 2012 London Olympics Site and Facilities Infrastructure
9. WPPSS 2 Washington Public Power Supply System Nuclear Unit 2
10. Barakah Nuclear Energy Plant

These large FOAK projects spanned a period of nearly 40 years from the early 1980s to the present. They all dealt with similar challenges involving enormous scope, new technologies, complicated interfaces, changing regulatory requirements, and numerous project stakeholder organizations. The common thread of key lessons learned and best practices that supported success involved an owner-led integrated project team approach reinforced with extreme leadership and commitment by top management stakeholders.

The 2020s will advance new nuclear technologies from design concepts to reality, ushering in a wave of nuclear innovation that will change how we power our future. We expect the construction of these first advanced reactors to begin in the early 2020s. Building these first reactors on-time and on-budget will be an important factor in enabling the scale of new nuclear deployment that will be needed to achieve zero to very low carbon emissions by 2050.