EM-5.22 Lessons Learned Bulletin

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V.C. Summer Nuclear Power Plant Project Failure

Contact: **Johnnie Newson, EM-5.22** johnnie.newson@em.doe.gov
202-586-8849

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Statement:

Construction of any large facility, such as a nuclear power plant or a large dam, runs the risks of cost overruns if design and/or construction is delayed. The V.C. Summer commercial nuclear power plant in South Carolina, which was in the process of building two new reactors, has experienced enormous cost overruns and schedule delays such that the project owners have canceled the project.

Lessons Learned from the construction of commercial nuclear power plants are directly applicable to current DOE EM major capital assets projects. DOE has recognized these issues and have addressed them in the updated DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, and other recent policy directives.

Discussion:

Background

Early in the 2000's, the United States was poised to reinvigorate the commercial nuclear power industry. Dozens of licenses to construct new reactors were in process with the Nuclear Regulatory Commission, and construction of four new reactors had started by 2008. Two additional reactors were in progress at the Alvin W. Vogtle plant in Georgia, and two new units were being built at the Virgil C. Summer plant in South Carolina. Earlier this year, however, facing severe cost and schedule overruns, the owners of the VC Summer plant decided to discontinue construction of the new units. Perhaps even more devastating, one of the country's oldest nuclear design and construction companies, Westinghouse, declared bankruptcy while its parent company, Toshiba, taking a $6B loss, pulled them out of the nuclear construction business.

Discussion

The reasons for expecting a "nuclear renaissance" just after the turn of the century were pretty clear. Based on the previous 10 years of economic growth in the United States, there was a perceived need for increased energy in the next few decades. Fueled by climate change politics, nuclear power plants were professed to be a "green" provider of energy (i.e., they produce no greenhouse gas emissions) and would replace outdated, "dirty" coal plants. In fact the US Government was willing to provide tax credits and loan guarantees for new nuclear power plants, similar to the ones that were proposed for renewable energy sources. In July 2005, the United States Congress passed the Energy Policy Act with the purpose, in part, of promoting the growth of the nuclear power. Finally, a new design, the AP1000, was developed by Westinghouse with better safety controls, simplified structures and a new construction process planned to efficiently build modules off site.

So what happened to the VC Summer plant? The plant experienced significant schedule delays due to a number of issues. US companies, having been out of the nuclear manufacturing environment for three decades lacked the equipment and expertise to build large components needed for the plant. This caused the plant to look overseas to get equipment manufactured which added schedule delays and cost to the project. Numerous errors occurred in construction including improperly installed rebar in the foundation of the plant causing rework and long schedule delays. The AP1000, although touted as a simplified design, was still a "first-of-a-kind" design, and a multitude of components needed to be reworked. Another major contributor was the 2011 major accident at the Fukishima nuclear power plant in Japan. A tsunami caused by a massive earthquake hit the plant causing power outages and the loss of cooling water to several reactors resulting in a radioactive release to the environment. Regulator inspections and safety standard reviews as a result of the Japanese accident significantly slowed plant construction. The US federal

government was providing tax credits for completing these plants, however, they had to be online by 2021, driving the construction to start before all design was completed. It was reported that the project never had a comprehensive, site specific plan or schedule, so there was no baseline for predicting schedule or cost problems. Finally, the economics of power demands in the US changed as well. A new focus on energy efficiency along with the economic recession of 2008, caused energy demands to plateau. New cheaper sources of power became available led by an increase in the volume of natural gas available due to the boom in fracking. Based on the original two new reactors budgeted to cost $11.5B and be operational in 2018, the final cost was anticipated to be in excess of $20B and at least three years delayed in starting.

Conclusion

Due to significantly increased cost and schedule, Southern Carolina Electric & Gas (SCE&G) and Santee Cooper, partners in the project, decided to halt construction of the two new reactor plants being built at the VC Summer commercial nuclear power facility in South Carolina. The reasons for the stoppage were many – change in business environment for new sources of power, vendor procurement issues, first-of-a-kind design causing delays, lack of NQA-1 vendors and experience, fabrication problems with modules, construction quality issues – among many others. There is significant fallout arising from the project failure at VC Summer. The CEO of Santee Cooper, the junior partner in the project, has retired as of September 1. The South Carolina House of Representatives have held hearings on the failure of the project and along with the South Carolina Attorney General, have requested a criminal investigation to be conducted. In addition, the FBI has admitted that they are engaged in a federal investigation of the project. Potential charges include misleading regulators about the health of the project at hearings regarding rate hikes to pay for the project, concealment of a 2016 independent report by Bechtel which outlined many of the project's issues, and potential use of unlicensed engineers designing parts of the reactor system. SGE&G originally filed a petition for abandonment of the project, but has recently pulled back the petition until outstanding issues can be resolved, or until they can find an interested buyer to finish the project.

The Department of Energy's Office of Environmental Management has similar large, first-of-a-kind design nuclear construction projects. Many of them have experienced significant cost and schedule overruns, however, there is very little alternative for the DOE except to complete the projects. The DOE uses many orders, guides and procedures to help manage the front-end planning, budgeting, scheduling and construction of these projects. The same issues experienced by the VC Summer project are directly applicable to and are being seen by the DOE projects, as discussed below.

Recommended Actions:

There are a number of lessons learned that have arisen from the failure of the VC Summer nuclear power plant construction project which are directly applicable to the major capital asset projects being managed by DOE EM. The DOE uses an order, DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, to help manage the front-end planning, budgeting, scheduling and construction of these projects.

The following are key lessons learned from the VC Summer construction project and following each is a reference to applicable sections from DOE Order 413.3B that addresses each item:

- Evaluate Alternatives - Nuclear plant owner should conduct an extensive evaluation of market conditions, future power needs, energy portfolio diversification, and competing energy sources before submittal of a Combined Construction and Operating License (COL) to the NRC.
    - DOE O 413.3B – Appendix A, Table 2.1, Conduct an Analysis of Alternatives (AoA) that is independent of the contractor organization responsible for the proposed project, for projects with an estimated TPC of $10M or greater.

- Project Assessment - Nuclear plant owner must continuously assess the contracted cost and schedule and contract provisions, and report potential overages to their utility regulator (the PUC) and receive authorization for prudency to increase costs. Owners must also continue to review, assess and take action for potential and realized risks on their projects.

- DOE O 413.3B – Appendix A, Section 6.a, When the integrated project team, Program Office, or independent oversight offices determine the Performance Baseline scope, schedule, or cost thresholds will be breached, the Program Office is required to conduct an independent and objective root cause analysis to determine the underlying contributing causes of cost overruns, schedule delays, and performance shortcomings. The root cause analysis will be provided to the PME as part of the rebaselining process to inform the PME's decision of whether to terminate or proceed with the project. Corrective actions shall be identified and presented to the PME for action approval.
- DOE O 413.3B – Appendix C, Para 24, States that Risk Management is essential part of every project and must be analytical, forward looking, structured and continuous. Risks for capital asset projects should be part of baseline process and should be reflected in contingency, budgetary requests and funding profiles.

- Prepare Project Baseline – each phase of the project requires different processes, sequences and resource requirements. Each phase needs to be planned, scheduled and integrated into an approved baseline.
  - In DOE O 413.3B - Appendix A, Section 4.c, CD-2, Approve Performance Baseline states that a project baseline which includes identified and assessed risks and uncertainties shall be established and will include Total Project Cost, a schedule completion date and minimum Key Performance Parameters.

- Proper Planning – having a comprehensive, integrated schedule linked to the performance baseline of all activities is vital. Identification and consistent monitoring and attention to critical path activities is key to staying on schedule.
  - In DOE O 413.3B - Appendix C, Para 17, Planning and Scheduling states that projects shall develop and maintain an integrated master schedule which should be consistent with Best Practices and the GAO's Schedule Assessment Guide (GAO-12-120G).

- Design Maturity - One of the major changes required by the NRC in 10CFR 52 is having design complete before commencing construction
  - In DOE O 413.3B - Appendix C, Para 7a Design Management for Nuclear Facilities states that Hazard Category 1, 2 and 3 nuclear facilities shall achieve at least 90 percent design completion the approval of the performance baseline.
  - For Major System Projects, conduct a Technology Readiness Assessment and develop a Technology Maturation Plan, as appropriate. At this stage, each critical technology item or system shall achieve a Technology Readiness Level-4.

- Effective Project Management – Ensure that the project scope, schedule and cost is fully understood and managed to success.
  - DOE O 413.3B, Appendix C, Section 1, Project Management Principles states that a program manager is important to ensure that projects are properly phased, funded over time and meet their key milestones. Program managers will ensure proper resourcing for success and they shall identify and quantify in terms of cost and/or schedule contingency to manage programmatic risks. They should put mitigation strategies in place to minimize risks.

Critical Decision(s):	CD-3 to CD-4
Facility Type(s):	All
Work Functions(s):	Project/Program Management
Technical Discipline(s):	All

References:

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4. Sammy Fretwell and Avery Wilks, “Long-secret report details ‘significant’ problems at failed nuclear reactor project”, The State newspaper, September 4, 2017.
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6. Darrel Proctor, “Bechtel In, Fluor Out as Vogtle Construction Continues”, Power Magazine, August 31, 2017.
7. DOE Order 413.3B Chg 3, *Program and Project Management for the Acquisition of Capital Assets*, December 20, 2016.