Lessons Learned and Observations from DOE’s Ongoing Nuclear Facility Design and Construction Projects

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A series of recent high profile nuclear facility design and construction projects setbacks resulting in significant schedule delays, and cost overruns, attributed -- in part -- to lack of effective quality assurance

- Share operating experience and lessons learned associated with DOE’s ongoing nuclear facility design and construction projects

Although DOE’s dynamics and operating environment are fundamentally different than commercial nuclear industry, the substance of issues and potential remedies are similar in nature

- Design and technology issues
- Availability and adequacy of needed technical expertise and skill-mix
- Project management experience, cost and schedule controls
- Regulatory clarity, customer expectations, and stakeholders input
- Effectiveness of acquisition, procurement and contracting
- Performance monitoring and oversight
- Accountability mechanisms
Background:
Overview of DOE

DEPARTMENT OF ENERGY

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Daniel B. Poneman,
Deputy Secretary*

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Dr. Steven Chu, Secretary

Office of the Secretary
Dr. Steven E. Koonin
Under Secretary for Science

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Office of the Under Secretary
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* The Deputy Secretary also serves as the Chief Operating Officer

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Energy Information Administration
Finance & Financial Administration
Western Area Power Administration
Southwest Power Administration

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EM Business Profile

- Workforce: 34,000 (Federal and Contractor)
- Geographic presence: 23 Sites in 15 States
- Projects:
  - Number of Projects: 74
  - Capital Projects.
    - Waste Treatment Plant (WTP): $12.3B
    - Salt Waste Processing Facility (SWPF): $1.1B
    - Sodium Bearing Waste Treatment Project (or IWTU): $890M
  - Operating Projects
  - Decontamination and Deactivation Projects
- Budget:
  - $5.9 billion in Fiscal Year 2009
  - $6 billion in American Recovery and Reinvestment Act funding
    - ~12,000 contractors
Waste Treatment Plant

High-Level Waste Facility
(77% Eng. – 49% Proc. - 23% Const.)

Pretreatment Facility
(72% Eng. – 34% Proc. - 27% Const.)

Analytical Laboratory
(74% Eng. – 66% Proc. – 53% Const.)

Low-Activity Waste Facility
(88% Eng. – 73% Proc. - 58% Const.)

Balance of Facilities
(71% Eng. – 41% Proc. - 61% Const.)
Waste Treatment Plant – HLW Facility
Project mission is to provide treatment of approximately 900,000 gallons of liquid tank waste stored at the Idaho Tank Farm Facility to a stable waste form for disposition at the Waste Isolation Pilot Plant.

Overall facility size: 53,000 sq ft
To date (40% completion): 600 tons of steel rebar and 4,000 cubic yard of concrete have been used.
Contract Issues

- Lack of technical specifications
  - Design requirements
  - Standards
- Inconsistent requirements
  - NQA-1
  - Design build
- Project definition
  - Process parameters
  - Overly conservative assumptions
- External influences
- Oversight expectations
Seismic Issues

- Design phase began before geotechnical investigation and report are completed;
- Functional classification changes during design phase;
- Designer does not have geotechnical and specialty skills needed to understand regulatory requirements and complete required analyses;
- Lack of clear standards;
- Lack of experienced technical support needed for a highly specific Request for Proposal (RFP);
- Lack of oversight personnel in the fields of civil, geotechnical and earthquake engineering and geology and seismology.
Several DOE capital projects experienced cost and schedule setbacks
- Some setbacks were attributed to changing requirements and evolving expectations through facility life cycles
- Some of the changes or added expectations were introduced late in the design or in the construction phase

Code of Record (COR) refers to the set of requirements in effect at the time a facility or item of equipment was designed and accepted by DOE

Universe of requirements includes:
- Applicable Federal and state laws and regulations
- DOE Directives
- Specific design criteria defined by national consensus codes and standards

COR is a single consolidated source document to facilitate accessibility and maintainability of the requirements throughout project lifecycle
- Initiate COR Development
  - At conceptual design phase *prior* to CD-1 approval
  - Update COR: At preliminary design phase *prior* to CD-2 approval
- DOE Review and Approval of Finalized COR
  - *Prior* to CD-2 approval
- Contractor to place the COR under change control *before* initiation of the final design phase
- Back fit during final design, construction, operation, and decommissioning
  - Supported by technical evaluations, including cost-benefit analyses on project safety, cost, and schedule
- COR shall remain under configuration management and be kept up to date to reflect DOE approved exemptions from, or equivalencies to, requirements
Legacy Quality Assurance Issues
(Institutional-Federal Level)

- Lack of QA organization and/or an QA manager
- Project QA documentation had not been established or was inadequate.
- Field offices had not performed a QA program audit of the project that included all the QA criteria invoked on the project.
- Insufficient QA personnel to perform effective oversight of projects.
- Lack of NQA-1 certification program for lead auditors, auditors, and technical specialists.
- Integrated Project Teams (IPTs) relied heavily on the ability to matrix needed expertise from site personnel, often resulting in insufficient resources to adequately support FPDs.
- Most oversight activities were as a result of events that had already occurred and were reactive rather than proactive in nature.
- Contractor QA organizations did not have a direct line of access to responsible levels of management.
- Projects had not documented and executed adequate internal or external interface control plans for the execution of work between multiple organizations.
- Insufficient documentation for the purchase of commercial grade items and services.
- The quality level determination process was site specific and lacked consistency across the complex.
- QA professionals lacked organizational freedom from cost and schedule to independently perform their function.
- Software configuration management.
QA Lessons Learned

- Develop a stable NQA-1 program
- Ensure that Senior management is aligned
- Ensure QA is integrated in acquisition strategy and procurements
- Ensure QA requirements are in your subcontracting practices
- Utilize Commercial Grade Dedication requirements (use EPRI Guidance) —
  - Ensure you have access to your vendors /subcontractors’ activities and maintain real-time operational awareness of their QA programs
  - Verify each level of your procurement chain - audit your sub-tier suppliers often
- Establish and maintain document control and records mgmt systems early
- Ensure adequate number of qualified QA personnel
- Identify key leaders in organizations—promote dialogue and sharing of operating experience
- Emphasize root cause analysis (extent of condition) to ensure that any proposed corrective action addresses the underlying QA performance drivers
Typical Lines of Inquiry

- **Technical:** Are there any unresolved issues associated with technology, design, nuclear safety, construction, and the potential operability and reliability forecasts that could impact project cost and schedule?
- **Cost, Schedule, and Risks:** Are costs and schedule estimates, including the contingency and risks, reasonable to be able to complete the project within budget and on time?
- **Construction Process:** Are construction activities proceeding as scheduled with focused constructability reviews to continuously improve the overall effectiveness and schedule?
- **Management:** Is the project being properly managed for its successful execution? Is the management approach effective?
- **Environment, Safety, Health (ES&H), and Quality Assurance:** Are ES&H and Quality Assurance programs, controls, and processes sufficiently mature for the project’s current stage of development?
- **Commissioning:** Does the project team have the programs in place and is there a common understanding of the importance of commissioning by engineering, construction, and operations? Are the commissioning budget assumptions and allocations reasonable?
Lessons Learned

Objective: Improve Project Performance

- Minimize project surprises—Design, technology, construction, stakeholder expectations
  - Ensure that the projects have the technical, safety, and quality requirements and standards properly identified and adequately implemented.

- Bring projects under control—Manage and control costs and schedule
  - Validation of consistency with agreed upon mission and project requirements
  - Validation of project progress and maturity consistent with CD expectations and likelihood of successful completion as planned, budgeted and scheduled

- Remain an informed and engaged “owner”
- Enhance indigenous technical capabilities
- Pinpoint and shed light on accountability
- Clarify roles and responsibilities of various layers of players at HQ/Corporate, Field/sites, and contractors

- Decision makers need to be empowered with clearly established principles that support the project milestones and execution—Transparency, predictability, and stability in process
  - Develop evaluation criteria and attributes to support the decision making process for appropriate implementation of requirements and standards through the critical phases of a project.

- Establish meaningful performance measures for each project
### Issues, Risk, & Strategies for Consideration

#### Technical Resources
- Shortage of craftsmen
- Shortage of engineers
- Labor productivity lower than expected
- Labor agreements target performance and escalation
- Emphasize work package detail and clarity
- Partner with educational institutions to enhance workforce and recruit
- Disciplined use of contractors

#### Contracts
- Escalating prices of materials, labor, and parts
- Cannot address all risks
- Technical Specifications
- Develop strategies to address fluctuating prices
- Procure long lead time equipment with separate contracts
- Establish open book relationship with EPC
- Use independent cost estimation
- Smart buyer…specify details in the contract

#### QA/Supply Chain
- Delay in delivery of key components
- Materials and components out of specification and tolerances
- Build necessary skills and oversight processes for management to protect against issues and delays
- Leverage demand and relationships to acquire an advanced queue position
- Leverage modular fabrication to reduce complexity and field work
- Define and execute robust QA/QC programs

#### Project Execution
- Project site-related risks
- Construction and project management risks
- Change Control
- Front-end load for project planning and design
- Utilize risk assessment as a management process
- Establish a relentless Project management model and capability
- Establish early change control processes and expectations