Lessons Learned for Nondestructive Assay to Support D&D

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Safety Systems Oversight

The Portsmouth Gaseous Diffusion Plant is in the Initial Stages of D&D

- Constructed in the early 1950s to enrich uranium
  - Began operations in 1954
  - Leased uranium enrichment operations to USEC in 1993
  - USEC ceased operation in 2001
  - Cold standby held in readiness to restart until 2005
- Gaseous diffusion process buildings returned to DOE October 1, 2010
  - Fluor-B&W Portsmouth LLC selected as prime D&D contractor

Uranium is Held Up in the Three Major Process Buildings

- Three major process buildings
  - X-333 – largest process equipment, lowest ^{235}U assay
  - X-330 – mid-sized process equipment, LEU
  - X-326 – smallest process equipment, HEU
- UF_6 was processed, some of which remains as holdup
  - Reaction of UF_6 with cascade materials (small, uniformly distributed mass across the interior surface of the cascade system).
  - Reaction of UF_6 with moisture in air leaked in to process (larger, heterogeneously distributed mass).

Characterization Methods

- Characterization of the cascade equipment requires more than one technique or method.
- Physical sampling and lab analysis provides data for cases that can be described as homogeneous (e.g. the interior surface of the cascade equipment).
- Physical sampling provides data on:
  - Non-radioactive contaminants
  - Radioactive contaminants at low levels or which do not provide a usable signal for radiation measurement instrumentation.
  - Contamination levels lower than detectable by Nondestructive Assay (NDA).

NDA Characterization Methods

- NDA is used to characterize equipment that can not be characterized using traditional sampling and analysis.
- NDA is used to characterize much of the cascade equipment due to its size and potential for holding up localized deposits of fissile material resulting from wet air in-leakage.
- Gamma rays, neutrons produced by deposits are typically sufficient for using NDA characterization methods.
- Benefits of NDA include;
  - Measures entire item (not biased by sample location)
  - Does not require sample (therefore no sample waste)
- Challenges of NDA include
  - Developing techniques that can be technically supported
  - Documentation of quality assurance is not standardized

D&D Has Already Been Performed at East Tennessee Technology Park (K-25)

- Buildings K-29, K-31, and K-33 complete
  - Largest and middle-sized process equipment
  - Depleted through LEU
- Building K-25 in progress
  - Smallest process equipment
  - HEU
- Building K-27 not yet started
  - Small process equipment
  - Less than 20% ^{235}U assay

K-25 D&D Experienced a Number of Issues with the NDA Measurement Program

- NDA for the LEU buildings was adequate
  - Off-site disposal with a WAC that could be met by the NDA measurement program
  - All process equipment removed, treated (if necessary), and then characterized (NDA was performed post removal of equipment)
- Problems were experienced with NDA in Building K-25
  - Attempts were made to use in-place measurements
  - Significant portions of the building were not safe for D&D work to proceed
  - ^{99}Tc present, cannot be detected by NDA
  - The process for determining Uncertainty of NDA measurements was not defined

K-25 NDA Measurement Program History

- As part of the K-25 D&D project, NDA characterization data was determined to be necessary to support the safe and compliant disposition of gaseous diffusion equipment that had residual uranium deposits (fissile material).
- Several other characterization methods were also employed in support of the project, including visual inspection, and analytical sampling. However, NDA measurements were deemed necessary for components that were not amenable to the other characterization methods.
- The NDA measurement program in place at the beginning of the D&D project was developed to support safeguards and security programs. The D&D project decided to use the existing NDA measurement program to meet NCS incredibility criteria and to meet waste disposal criteria.
- As part of the D&D project, the safeguards NDA measurement program was used to generate new characterization data to supplement the historical NDA data.

K-25 Readiness Review Results

- DOE Operational Readiness Reviews of the D&D project revealed that the quality of the data was less than adequate for supporting the D&D project needs related to nuclear safety and satisfying waste acceptance criteria.
- DOE directives do not invoke particular standards or quality assurance requirements that are directly applicable to NDA measurement programs.

K-25 Readiness Review Corrective Actions

- The K-25 D&D project developed a corrective action late in the characterization process.
- Corrective actions for the K-25 project included the development and implementation of new validation processes for the NDA measurement methods.
- Following the identification of the less than adequate quality assurance requirements, the D&D project decided to continue using the NDA measurement methods (at risk of not being able to use the data) and validated the measurements methods after the fact. This was done to minimize the impact on the project schedule that had already been negatively impacted by the inadequate characterization planning.
- The validation involved the development of Working Reference Material (WRM) standards. The WRM standards were then used to validate the NDA methods through a formal validation process.
- The validation processes were successful in providing the quality assurance necessary to support the characterization requirements for nuclear safety and waste acceptance criteria.

Similarities and Differences between NDA Programs at K-25 and Portsmouth

– Similarities:

- The X-326 facility is similar to the K-25 building with respect to size and type of equipment and types of contaminants and hold up (HEU and Tc99).
- The D&D project is following operations and S&M. The characterization and safety programs supporting operations are being considered to be used to support D&D project needs.
- The NDA program currently in place at Portsmouth is similar to NDA program in place at the beginning of the K-25 project.
- The staffing level and qualification of staff is based on supporting plant operations rather than a large characterization effort.
- The Portsmouth D&D project faces many of the same programmatic choices as the K-25 D&D project.

Similarities and Differences between NDA Programs at K-25 and Portsmouth

- Differences
  - X-326 deposit removal operations have been far more extensive than the K-25 efforts.
  - The X-326 facility condition is far better than the K-25 facility. This is particularly important relative to the condition of the roofing.
  - Some of the techniques used in the Portsmouth NDA program have an advantage over the techniques used at K-25. Portsmouth NDA techniques include differential peak analysis that allows the identification of self shielding effects due to thick deposits and provides some indication if deposits are localized.

Similarities and Differences between K-25 and Portsmouth (Cont.)

- Program weaknesses are the same
  - Determination of overall measurement uncertainty is not performed.
  - Quality assurance requirements are not well defined and integrated within the NDA program.
  - The NCS requirements relative to characterization data and the associated data quality objectives are not clearly defined.
  - Regulatory drivers for implementation of standards have not been developed or implemented within the DOE complex.
  - DOE has developed an implementation plan ; however, the associated DOE implementation plan schedule has not been integrated into the schedule for the Portsmouth D&D project.
- The lessons learned at K-25 are known and can be applied to the Portsmouth project.

PPPO Corrective Actions

- Quality assurance requirements were developed based on current quality assurance requirements that have been documented within the programs used to assess analytical programs.
- The quality assurance requirements address the deficiencies identified in DNFSB recommendation 2007-1.
- PPPO coordinated its efforts with the DOE Consolidated Audit Program (DOECAP).
  - Mature and effective DOE program used across the complex to evaluate the quality assurance practices within the analytical laboratory processes.
  - The quality requirements for NDA developed by PPPO mirror the quality requirements for analytical processes.

PPPO Corrective Actions (Cont.)

- Quality requirements include evaluation of NDA measurement programs' ability to:
  - Perform energy and efficiency calibrations of equipment
  - Generate reproducible data
  - Train and recertify staff
  - Verify modeling procedures, manage records
  - Define limits of detection
  - Establish deterministic processes for establishing uncertainty

WRM Standards for NDA Validation

- Two sets of WRM standards
  - Set of three drums of contaminated alumina that have been highly characterized.
  - Set of specially prepared one inch diameter thin metal tubes containing manufactured UO_2F_2.
- Development of WRM standards was funded by DOE EM-22
  - WRM standards used to validate non-in-situ NDA methods.
  - Passive neutron counting techniques that will be used to measure large process equipment in a low background will be the primary user of the WRM standards currently being developed.
  - Additional standards are needed.
  - WRMs provide a benchmark that is used to confirm that measurement methods are performing within their stated capabilities.

PPPO Example Using this Process

- A large inventory of alumina trap media waste containing fissile material at the Paducah project.
  - Quality assurance plan was developed and implemented - included the quality assurance principles present in the previously described DOECAP quality requirements document.
  - Prime contractor provided oversight of the subcontractor providing the measurement service to ensure that the QA plan was adequately followed.
  - PPPO developed and preserved three of the drummed containers as working reference material standards.
    - Standards will be used to support the Portsmouth D&D project.

Path Forward

Decisions Required

- How to implement requirements through existing contracts

Projected Impact

- Cost of not taking action
  - Significant cost and schedule delays.
- Cost of taking action
  - The development of quality programs (procurement of sufficient standards)
  - The development of oversight programs.

Current Status or actions that need to be taken

- Implementation of Oversight programs, including the communication of requirements and lessons learned
- Deployment within current activities and the transition to fully implement the contractor and oversight programs.