MANAGING TECHNOLOGY PROGRAMS TO SUPPORT CLEANUP AT HANFORD

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ABSTRACT

The application of science and technology contributes significantly to meeting environmental cleanup objectives at Hanford. Under a unique partnership between Fluor Hanford (FH) and the Pacific Northwest National Laboratory (PNNL), technologies and alternative technical solutions are being developed and applied to solve some of Hanford's most technically challenging problems. Challenges under the FH scope of work include the stabilization of plutonium-bearing materials, the removal of spent nuclear fuel from sites adjacent to the Columbia River, deactivation of nuclear facilities, and the characterization, certification, and treatment of both low-level and transuranic waste.

BACKGROUND

Recently implemented management practices have promoted the successful application of technologies. These practices establish a structured process for technology planning, provide a strong management commitment to address near- and longer-term technology needs, facilitate active involvement of and collaboration between technology programs and projects, encourage innovation, enhance decision making, and hold technology organizations and projects accountable for measurable results.

The application of these "best practices" has directly affected the project's ability to enhance the technical baselines. Fluor Hanford began work at the Hanford Site as the manager and integrator of the performance-based Project Hanford Management Contract (PHMC) on October 1, 1996. Under the original PHMC terms, FH was to focus its efforts on management and integration and crosscutting site wide functions. To that end, FH established a Technology Management organization to perform the technology integration and cross-cutting efforts. In October 1999, FH initiated a restructuring of the contractual work scope responsibilities with its major subcontractors and implemented a project-focused organization. Under the restructuring program, additional emphasis was placed on innovative approaches to accelerate progress of the Hanford Site mission. This increased emphasis on innovation led to the recent implementation of a Memorandum of Agreement (MOA) with PNNL to enhance the technology program.

The agreement is providing the FH team with much-improved access to technical expertise and technologies to accelerate cleanup. The MOA assigns PNNL the leadership for the technology management function in support of FH projects. Key elements of the technology program include integrated technology planning to identify technology needs, implementation of science and technology reviews and roadmaps to produce improved and more defensible baselines, and streamlined methodologies that have been used to highlight the benefits derived from alternative technologies. Under the terms of the MOA, PNNL provides direct technical support to help the project meet baseline objectives and identifies breakthrough initiatives, coordination and linkage with the external science and technology (S&T) community (including national laboratories, other U. S. Department of Energy (DOE) sites, and universities), verification of technical baselines to better understand areas of highest technical risk or uncertainty, and support for site closure activities including the identification of project closure activities.

The technology strategies implemented by the FH/PNNL team include 1) building a strong understanding of the project needs and technical challenges, 2) challenging the projects to improve on baseline technologies (reduce cost, schedule and risk), 3) applying the best solutions from industry, other DOE sites, the national laboratories, and 4) transfering (exporting) technologies that have been successfully used at Hanford. The application of these strategies has enabled us to enhance project ownership of the technology needs and to develop a real-time needs identification process that is consistent with DOE requirements. The FH/PNNL team has also prototyped the implementation of additional technology planning efforts, including the preparation of science and technology plans for the projects and the identification of key out-year technology decisions known as Technology Insertion Points (TIPs).

SCIENCE AND TECHNOLOGY SUCCESS STORIES

Examples of recent successes include technologies used to

- convert plutonium-bearing material to a stable form
- move hazardous nuclear materials away from the Columbia River
- deactivate and demolish contaminated facilities.

CONVERSION OF PLUTONIUM-BEARING MATERIALS

During the Cold War, the Plutonium Finishing Plant was the final link in Hanford's plutonium production activities. This 200 Area plant was where plutonium nitrate solutions were purified and converted into a solid plutonium metal for shipment to government weapons production facilities. The Hanford Site mission changed from defense production to cleanup in 1989, and in 1996, the Plutonium Finishing Plant received its shutdown orders from the DOE Headquarters.

Now, the Plutonium Finishing Plant is ramping up several major processes to stabilize its large plutonium inventory as part of the effort to transition the Hanford central plateau for long-term waste management. The Nuclear Material Stabilization Project's goal is to safely stabilize the plutonium inventory at the Plutonium Finishing Plant and deactivate and dismantle the contaminated buildings.

Until then, the Plutonium Finishing Plant staff is responsible for safely maintaining 4 metric tons of plutonium in 17.8 metric tons of bulk plutonium-bearing materials left from defense production. The materials are in a variety of forms such as metals, oxides, liquids, polycubes (plutonium bound in plastic) and residues that must be stabilized. During the past year, the first two stabilization processes have been started up at the Plutonium Finishing Plant, and several additional startups are planned. Key technologies involved in this effort include the following:

- Thermal Stabilization – The Plutonium Finishing Plant has approximately 5,000 items of plutonium-oxide and mixed-oxide materials that will be thermally treated in small muffle furnaces. Heating drives out moisture and volatile chemicals, converting the materials to a stable oxide powder. The rate of stabilization in fiscal year 2000 has been accelerated. Operational experience, along with safety and environmental analyses, determined that the amount of feed material could safely be increased. Additionally, technical enhancements of the muffle furnaces are scheduled for implementation in fiscal year 2001. These furnace enhancements are expected to further increase throughput.

- Bagless Transfer System – A glove box load-out system developed at Savannah River will be deployed at the Plutonium Finishing Plant. The system allows plutonium convenience cans to be directly placed and sealed into a second metal container external to the glove box. This will eliminate the past practice of "bagging out" plutonium, thereby reducing worker exposure and provide accelerated methods of plutonium handling.

Fig 1, Bagless Transfer System

- Plutonium Solution Stabilization – Testing of a prototype vertical denitration calciner was restarted in August 1999. The calciner uses heat to convert plutonium nitrate solutions to stable oxide. Originally, a full-scale calciner was being built to stabilize 4,000 liters of solutions. Subsequently, a simpler, different process was selected and work on the production calciner was halted. The selected process, magnesium hydroxide precipitation, will simplify stabilization, accelerate progress and reduce costs. This process has been highly successful at other DOE plutonium facilities.

- Simplified Polycube Stabilization – These two-inch cubes were used earlier for criticality experiments, and were expected to require special pyrolysis equipment for stabilization. However, through extensive testing and analysis, it has been determined that instead of using the two-step pyrolysis process, which requires installation of new equipment, the polycubes can be safely stabilized in existing muffle furnaces.

Fig 2, Polycube Sampler

SPENT NUCLEAR FUEL DISPOSITION

Additional technology contributions include efforts to move hazardous nuclear materials away from the Columbia River as part of the Spent Nuclear Fuel Project. The Spent Nuclear Fuel project is challenged with moving more than 2,300 tons of spent fuel, sludge, debris, and contaminated water away from the Columbia River. The complex work planned for the project over the next 6 years has never been done anywhere in the world. The majority of Hanford's irradiated nuclear fuel has been stored in the K-East and K-West Basins since the 1970s. The basins are located 1,500 feet from the Columbia River, and have leaked in the past.

Much of the equipment for the Spent Nuclear Fuel project has been designed, built and placed in the K Basins to accomplish this work where all Fuel Retrieval System operations must be done remotely underwater. A newly constructed Fuel Retrieval System opens the fuel canisters, removes, sorts and cleans the fuel, and loads the assemblies into specially designed steel baskets, which are then loaded into specially designed containers (Multi-Canister Overpacks [MCOs]). The spent nuclear fuel is then transported, processed and stored in MCOs. When sealed, these containers are designed to withstand internal pressures of more than 450 pounds. These shipping casks will be hoisted out of the K Basin water and loaded onto trucks for transport to Hanford Site's new Cold Vacuum Drying Facility.

The Cold Vacuum Drying Facility and its drying operation represent a one-of-a-kind, first-of-a-kind structure. After spent nuclear fuel has been removed from K-East and K-West Basins in MCOs, the fuel is dried in the facility and prepared for safe storage and surveillance in the Canister Storage Building. Key technologies involved in this effort include the following:

- Fuel Retrieval System and Spent Fuel Sorter – N-Reactor fuel currently stored in the Hanford K Basins will be repackaged, dried and moved to interim storage. The initial step is to remove the fuel from its current canisters and to place the fuel in MCOs, which will each hold about 200 fuel assemblies. The system to accomplish this transfer of fuel includes, as its most unique feature, a robotic arm to grasp the fuel and load each fuel element into baskets. Accompanying this is equipment to clean and dump existing canisters as well as equipment to load baskets of fuel into MCOs. Without the robotic arm retrieval system, each fuel element would need to be manually removed by operators standing on grating over the basin using grasping tools on long reach rods.

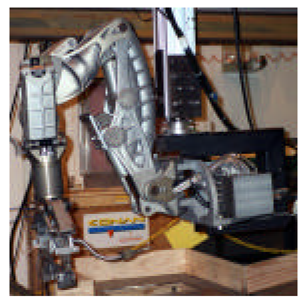

Fig 3, Fuel Retrieval System and Spent Fuel Sorter

- Cold Vacuum Drying Process – Sufficient water must be removed from the spent nuclear fuel MCOs to prevent over-pressurization from gas generation due to radiolysis and water-fuel reactions. The vacuum drying process consists of draining the bulk water from the MCO, heating the contents up to drying process temperature, vacuum drying the residual water, and final verification of water removal. A cold vacuum drying module was developed, tested, and installed to ensure that the water content within the container and spent nuclear fuel is within safe pressurization and gas generation limits.

- Non-Intrusive Pressure Monitor – The safety of a Spent Fuel Overpack is established by calculations showing that the pressure limits of the vessel will not be exceeded, but "defense in depth" drives the desire for confirmatory information. Data reflecting the pressurization will also be used to make judgments with respect to the eventual shipment of the N-Reactor fuel to a geologic repository. The challenge is to non-intrusively monitor the pressure in the sealed container. The monitoring device consists of a Bourdon gauge in a stainless steel canister overpack shield plug. A magnet is attached, through a series of miniature gears, to the gauge so that an increase in pressure results in a rotation of the magnet. A cap is welded over the shield plug and a compass-like magnetized needle gauge is mounted on the cap. This needle senses the rotation of the internal magnet in the shield plug, rotates in tandem with the magnet, and provides an indication of internal pressure.

- Integrated Water Treatment System (IWTS) – N-Reactor fuel is currently stored in the K Basin pools. The process to clean and transfer fuel from existing canisters to larger containers generates particulate of various sizes including very fine particulate that will cloud the basin water. A multi-stage system has been deployed to separate the generated particulate material into its various sized components and it will include appropriate steps in sequence such as knock-out pots, filters, and ion-exchange modules.

Fig 4, Corroded Spent Fuel with Particulate "Cloud"

DEACTIVATION AND DECOMMISSIONING PROJECTS

For more than 40 years, the 300 Area just north of Richland, Washington, was the center of the Hanford Site's radiological research and fuel fabrication. Those activities resulted in highly contaminated facilities and a large inventory of radioactive materials. Today, safely deactivating contaminated buildings and shipping radioactive and hazardous waste out of the 300 Area are among the highest of Hanford cleanup priorities. Currently, 300 Area cleanup focuses on deactivation of the 324 and 327 Buildings. These highly radioactive facilities contain heavily shielded enclosures (hot cells) that once were used to examine and test reactor fuel elements and other irradiated materials. Major progress has been achieved in the cleanout of the 324 Building B Cell, a three-story heavily shielded concrete room used for experiments on high-level waste. The largest and most highly contaminated equipment rack inside B Cell was dismantled and cutting was completed. As part of this work, a high-powered laser was demonstrated for cutting metal components. B Cell once held 12 such equipment racks. The final rack was disconnected and dismantled during fiscal year 2000. A new remote robotic platform is being installed for use in the large B Cell deactivation in the 324 Building. The platform will be used for further work in the 300 Area and elsewhere on the site. Key technologies involved in this effort include the following:

- Laser Cutting – A high-powered neodymium yttrium aluminum garnet laser technology is being developed for cutting apart contaminated glove boxes and equipment. The laser is paired with a robotic arm to perform the cutting, and a separate arm to handle the cut pieces. The system uses laser and robotic components that are commonly available and deployed in a variety of automotive and other industrial applications. A demonstration was conducted on an uncontaminated Hanford glove box, proving the ability of the laser-robot arm combination to accurately and smoothly follow complex paths. Programming of the robot arm movements was intuitive and simple, and the integration with the laser operation was safe and seamless. No significant problems were noted with the amount of sparking, potential safety issues, ventilation needs, or ability to fully penetrate stainless steel from 1/8-in. to 1/2-in. thick.

- Robotic Work Platform – The DOE Office of Science and Technology (EM-50) has partnered with the Hanford Site in a project to deactivate a highly radioactive facility containing tanks, vaults, hot cells, and chemical processing equipment. Through this project, Hanford is procuring and deploying a remote/robot work platform that is positioned with an overhead crane to perform deactivation activities. The work platform will have sufficient length and dexterity to reach all interior surfaces of the hot cell including the ceiling. It is designed to be used for hot cell equipment/debris removal in addition to other deactivation operations. The system will deploy a variety of end effectors such as shears, cutoff saws, decontamination spray heads, and detectors for characterization and non-destructive examination that are matched with the design of the platform to provide for convenient remote attachment. Use of the remote/robot platform will reduce the work time associated with manipulator change-out and repair, installation and removal of special tooling, and final cell cleaning. The result will be shorter cleanup schedules and reduced program costs.

SUMMARY

The FH/PNNL team continues to evaluate new management approaches and technologies to enhance cleanup of the Hanford Site. The Technology Management program has implemented a number of best practices that are contributing to sustained performance and the identification and implementation of enhanced solutions. We continue to use the best available industrial technologies and benefit from our linkage to the national laboratories. Our partnership with the DOE's Office of Science and Technology is enabling the deployment of alternative technologies.

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