

APPLICATION OF NEW AND INNOVATIVE TECHNOLOGIES ON THE 321-M FUEL FABRICATION FACILITY LARGE SCALE DEMONSTRATION & DEPLOYMENT PROJECT

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ABSTRACT

The 321-M Fuel Fabrication Facility was built in 1956. It's mission for 40 years was to fabricate fuel and target assemblies for irradiation in the site's production reactors. Although the facility was deinventoried in 1995, holdup quantities of highly enriched uranium (HEU) still remain in the ventilation ducts and some process equipment. For 40 years, fuel machining, cutting, and fabrication operations took place on the west side of the building and resulted in the contamination of this area. Approximately 9000ft² of the 60,000ft² facility is contaminated with alpha contamination. A portion of the facility overheads is potentially contaminated. The facility roof has outlived its warranty and has started to leak.

The goal of the 321-M Deactivation Project is to place the facility in a long-term, low-cost safe storage (SAFSTOR) condition. The end state vision for the project is to eliminate the radiological buffer areas and eliminate or stabilize the contamination areas in the building. The facility's baseline deactivation plan was issued in the spring of 1998 and reflected this vision. A recent baseline change proposal has advocated the project pursue several additional end points. This proposed expansion of the deactivation project would be met by a more comprehensive approach to floor decontamination; removal of the HEU that can be easily retrieved; isolation and containment of inaccessible areas that contain HEU; and the fixing-in-place of residual amounts of loose contamination. The deactivation project's baseline change request is being considered by the DOE-SR (Department of Energy – Savannah River) and WSRC (Westinghouse Savannah River Company) management team.

As an integrated activity of the 321-M deactivation, a Large Scale Demonstration and Deployment Project (LSDDP), funded by the EM-50 Office of Science and Technology, has been initiated. The LSDDP will demonstrate multiple innovative and/or improved technologies that support planned facility deactivation activities. Technologies that can perform a task better, safer, cheaper, and/or faster than the baseline approach will become candidates for deployment on future SRS, DOE complex, and commercial sector projects.

The Integrating Contractor Team (ICT) is a body specifically formed to manage the LSDDP technology identification, assessment, and selection process. The ICT consists of representatives from DOE-Savannah River, DOE-Federal Energy Technology Center, Westinghouse Savannah River Company, Bechtel National Incorporated, Duke Engineering and Services, Florida International University, Waste Policy Institute, NES Inc., and the Army Corps of Engineers. Seven innovative technologies have been selected as potential candidates for demonstration.

The approach to the deactivation is unique in that innovative or improved technologies will be used to characterize, decontaminate, stabilize, and/or selectively dismantle and size reduce

portions of the facility. In addition, technologies that protect the health and safety of the worker are also being considered. Alongside the innovative technology demonstrations, baseline or traditional technologies will be field deployed. The performance and cost data from the demonstrations will be analyzed and compared to the performance and cost data from the baselines to evaluate the effectiveness and efficiencies of the new technologies. Each technology demonstration will be evaluated in an Innovative Technology Summary Report (ITSR). Those innovative/improved technologies that prove successful will be endorsed across the DOE complex and in the commercial sector. The innovative/improved technologies will be demonstrated in government fiscal year 1999.

INTRODUCTION

On March 31, 1998, the Savannah River Site and the Department of Energy's (DOE) Federal Energy Technology Center (FETC) signed a Technical Task Plan (TTP) to initiate the 321-M Fuel Fabrication Facility Large Scale Demonstration & Deployment Project (LSDDP). The 321-M LSDDP was one of four DOE-sponsored large scale technology demonstrations that was approved in 1998. As specified in the TTP, the EM-50 Office of Science and Technology, along with DOE-SR's EM-60 Office, agreed to a 50/50 funding split for the integrated deactivation project/technology demonstration. The goal of the 321-M LSDDP was to demonstrate five innovative/improved technologies, while helping to solve problems or meet needs identified in the facility's deactivation plan. The timeline for the LSDDP called for these technologies to be demonstrated by the end of fiscal year 1999. The project team anticipates at least five technologies will be demonstrated in the facility. Each technology demonstration will be supported by a detailed performance and cost analysis report. This report is called an Innovative Technology Summary Report (ITSR). All reports from the LSDDP are published by DOE-FETC and enjoy a broad distribution across the DOE complex.

The 321-M LSDDP has four distinct phases:

Phase I Technology Identification, Assessment, and Selection

Phase II Procurement and Other Steps Leading to the Start of Demonstrations

Phase III Technology Demonstrations – Collect Performance & Cost Data

Phase IV Preparation of ITSRs

The SR project team, in concert with the Integrating Contractor Team (ICT), is tasked with finding innovative technologies that can address 321-M Facility needs, placing the technology providers under contract, performing the technology demonstrations, capturing the performance and cost data for the baseline as well as the innovative approach, and reporting the results.

The 321-M LSDDP has completed Phase I. Some technologies have progressed through Phase III: Others are in Phase II or Phase III of the project.

This paper includes a short history of the 321-M Fuel Fabrication Facility, a description of the 321-M Deactivation Project and how the technology demonstrations have been integrated into the project, a brief outline of the Integrating Contractor Team (ICT) process, and a technical review of the selected innovative/improved technologies.

HISTORY OF FACILITY

Operating History

Building 321-M, the Fuel Fabrication Facility, was completed in 1956. It was one of the first facilities at the Savannah River Site. Its purpose was to manufacture fuel assemblies for the production reactors. On occasion it was also used to assist in the manufacture of other items, such as target elements, and most notably the fuel for the isotope power generators on the Cassini space mission.

The fuel being manufactured in 321-M consisted of tubular uranium and aluminum assemblies. The major manufacturing processes included melting and alloying, casting, machining, extruding, and welding. Additional equipment included annealing ovens, cleaning vats, and inspection and assay equipment.

Since the facility processed highly enriched uranium and other accountable nuclear material, there was elaborate security in effect, with multiple physical barriers, electronic surveillance, and resident armed guards. In addition, the material was tracked and accounted for at every production step inside the building, and there was a high degree of segmentation. Operations were carried out by a staff of about 45, plus security forces.

The interior of the facility was organized into distinct areas, for accountability, for process and material flow control, and for contamination control. Material arrived in a receiving area. The fissile material was assayed and weighed, and then stored in a vault. All spaces where unclad uranium metal and uranium-aluminum alloy were processed were in a contiguous area for contamination control. This included the vault, a charge preparation area where the uranium and aluminum were weighed out, the casting room, the machining room, and a portion of the billet assembly and weld area. These rooms and areas were supported by separate ventilation systems with HEPA filtered exhausts.

Material leaving the contamination area consisted of uranium-aluminum cores. In the Billet Assembly and Weld Area, the cores were assembled into aluminum sheathed components. The final fabrication steps were carried out in the large, high bay finishing area and at the south end of the facility. The final fabrication steps included heatup and annealing, extrusion, trimming, final assembly, and quality inspections. The finished fuel tubes were then stored in a high-integrity, critically safe storage area commonly referred to as the honeycomb. Upon request, these tubes were assembled into fuel bundles and shipped to one of the site's production reactors.

Offices, toilets, change facilities, a lunchroom, a computer room, and maintenance shops were also provided for the staff.

Shutdown and Deinventory

The production reactors were shut down for various reasons during the 1980's. In the early 1990's, a major reactor restart effort at the Savannah River Site was undertaken, but this was discontinued when the cold war ended in 1992. Several of the reactors, and the fuel fabrication facility, were kept in standby for an eventual restart. In 1995, it was decided to permanently shut down the 321-M Fuel Fabrication Facility.

The permanent shutdown was accompanied by a "deinventory campaign". The finished fuel that was in storage and other raw materials were removed from the facility and shipped to designated storage areas on site. This allowed the high security measures at the facility to be discontinued. The electronic surveillance was cannibalized to serve other facilities; the armed guards were removed; the nuclear criticality instrumentation was cannibalized; and the computer system was dismantled. Cleaning and degreasing fluids were drained and flushed from facility tanks and vats. Finally, most 321-M personnel were reassigned. A small custodial force remained to perform surveillance and maintenance on the surplus facility.

Legacy Problems

Holdup Material

A significant and accountable quantity of uranium remains in the facility, inside ventilation and equipment enclosures, and gloveboxes and hoods. This material exists in various physical forms, ranging from a surface film, to dust and chips, to cuttings.

Contamination

One seventh of the building, about 9,000 ft², has been contaminated by uranium. The levels are high enough to classify this portion of the facility as a High Contamination Area. The contamination is pervasive, and exists on floors, walls, and equipment surfaces. The dust that accumulated in the overheads on light fixtures, ducts, conduit, pipes, and cable trays is also presumed to be contaminated.

Asbestos

In the 1950's, material containing asbestos was commonly used in construction. Much of it has been replaced over the years by non-asbestos materials, but there is still some that remains. Specific examples of asbestos include the insulation found on steam piping, insulation on ventilation supply ducts, and asbestos-cement siding panels (i.e., transite panels).

Lead and other Hazardous Materials

Lead shielding was used in various places, mainly to establish low background levels for the sensitive analysis instruments that were used during the manufacturing process.

Many cabinets remain in the facility, inside of which are a variety of chemicals, such as paints, lubricants, adhesives, dye penetrants, cleaners, and the like.

DEACTIVATION PROJECT

The 321-M Fuel Fabrication Facility is the responsibility of the WSRC Facilities Decommissioning Division (FDD). The deactivation of the facility will be carried out as a division-managed project.

SR Project Team

Planning

Planning the deactivation effort will be carried out by the project team.

The project team includes the following members:

- Project manager
- Project scheduling and controls engineer
- FDD Engineering representatives
- FDD Excess Facilities Management representatives
- FDD Program Management and Planning representative
- Radiological Controls representative
- Site Construction

Engineering

Engineering the deactivation effort will be carried out by the FDD Engineering representatives on the project team. Any specialized engineering, such as amendment of Hazard Baseline Documentation (e.g., safety basis documents) will be contracted out to the appropriate specialist organizations via a Work Authorization Document.

Conduct of Work

Field work will be performed by the subcontractors, the Site Construction forces, and the FDD Excess Facilities Management department, with assistance where necessary from other organizations. The site work control protocols will be followed.

End State Vision

This facility has been declared excess. Deactivation of the facility will place it into a passively safe configuration for long-term surveillance and maintenance. After deactivation is completed, the following end state is envisioned. The residual radioactive material in the facility, including some fissile material hold-up, will be isolated in place. All remaining equipment inside the facility will be retired in place with no identified requirements to remove. The roof will be repaired or replaced. The facility will be locked and permanently de-energized, including the shutdown of the remaining ventilation systems. All utilities will be isolated from the facility at the boundary. If the SR project team's baseline change proposal is accepted, enough highly enriched uranium will be removed from the facility to relax the safety basis requirements for criticality prevention. Surveillance will consist of an annual inspection to ensure the facility remains in a passive stable condition, and that the intrusion of rainwater, animals, or vermin, and unauthorized persons is precluded. The annual inspection may be repeated if necessary after a severe natural event such as earthquake, hurricane, or tornado.

LARGE SCALE DEMONSTRATION & DEPLOYMENT PROJECT

Integration of LSDDP into Deactivation Project

Technologies previously developed and currently used within the commercial nuclear industry and the DOE complex are generally sufficient to deactivate and decommission (D&D) surplus buildings and structures within the DOE complex. Some of these baseline technologies are labor intensive, time consuming, and indiscriminately expose workers to radioactive and hazardous materials. Many baseline technologies produce an excessive amount of secondary waste. The Deactivation and Decommissioning Focus Area (DDFA) is addressing these problems by facilitating the demonstration and deployment of technologies that are cheaper, quicker, improve worker safety, and produce less waste.

The large scale demonstration and deployment concept offers incentives to end users to accept the risks associated with the first time use of a technology. The DDFA partners with an EM-40 or EM-60 customer with an existing D&D project and funds demonstrations of innovative technologies on a scale large enough to effectively compare their costs to the baseline technologies. This is accomplished by a side-by-side comparison of an innovative technology against a baseline technology from an ongoing project. The fundamental requirement is that the LSDDP be performed as part of an actual D&D project and that the end user commits to further deploy those technologies that prove to be more cost effective than the baseline technologies.

Integrating Contractor Team

The technical aspects of the LSDDP are managed by an Integrating Contractor Team (ICT). ICT responsibilities include identification of innovative technologies that are compatible with the baseline needs of the D&D project, integration of the technology demonstrations into the baseline D&D project, evaluation of the innovative technology performance against the baseline technology performance, and communication of the results. ICT members include representatives from onsite and offsite organizations with expertise in the D&D industry. Following completion of the LSDDP, members are expected to transfer successful technologies to their future D&D projects.

The ICT for the 321-M LSDDP is composed of representatives from DOE-SR, DOE-FETC (the DDFA), WSRC, Bechtel National Incorporated, Duke Engineering and Services, Florida International University, NES, Inc., Waste Policy Institute, and the U. S. Army Corps of Engineers (USACE). The U.S. Army Corps of Engineers will perform the cost analysis of each innovative technology demonstration for comparison with the baseline technology. For consistent and objective cost analyses, the USACE has been tasked with performing the cost analysis for all LSDDPs funded by the DDFA.

Technology Screening Process

Potential technologies were identified using a variety of sources. Technology sources include the Technology Information System developed by the Hemispheric Center for Environmental Technology (HCET) at Florida International University, the TechKnowTM data base developed by the Global Environmental Technology Foundation, the D&D Technology Module developed by the Arrey Team for the DDFA, the TECHCON database, the RAPIC database, and responses to a WSRC-initiated Expression of Interest (EOI) and a DDFA-initiated Program Opportunity

Notice (PON). The EOI targeted about thirty D&D technology providers and was also published in the Commerce Business Daily (CBD). ICT members brought knowledge of potential technologies from their respective businesses and past projects. The DDFA identified technologies from their previous work in technology research and development. Technologies not used on the earlier large scale demonstration projects (Argonne, Fernald, and Hanford), were reconsidered.

The 321-M ICT reviewed potential technologies using a two tiered approach.

An initial screening included the review of vendors' brochures, or telephone calls to the vendor, to determine if the technology was compatible with the project baseline and had potential to improve the baseline. Technologies meeting the initial screening were then reviewed in detail. The ICT developed a set of technical criteria by which technologies were evaluated. Individual ICT members completed a technology screening form for each technology which was followed by a comprehensive evaluation by the ICT. For those technologies selected for demonstration, requests for proposals were sent to technology vendors. Subcontracts were awarded based on competitive bids or a sole source justification. Preference was given to those vendors willing to share the costs of the technology demonstration.

Technology Demonstrations

Strippable Coatings

Statement of Facility Problem

Approximately 9000ft² of the 321-M Fuel Fabrication Facility is contaminated with highly enriched uranium (HEU) and designated a high contamination area. Skin contamination cases can be easily prevented by wearing personal protective equipment. However, since most of the contamination is removable contamination, dismantlement and disassembly activities have the potential for stirring up the loose dust and creating an airborne radioactivity area. If inhaled, the alpha-emitting HEU could cause a host of internal problems. To make long-term surveillance and maintenance less hazardous for the facility monitoring teams, loose contamination areas should be decontaminated. Conventional decontamination methods are very labor intensive and result in the generation of a significant amount of secondary waste. A faster decontamination method that produces less waste is desired.

Description of Innovative Technology

Strippable coatings are one solution to this problem. A strippable coating is applied to a surface by spraying, rolling, or brushing. The strippable coating is allowed to cure for 24 hours. During this drying period, the coating binds the loose contamination in its polymer matrix. Once the coating has cured, it can be peeled or stripped from the surface it was applied to. Surface contaminants can be easily removed by this process. The intent is to remove enough of the loose radioactive material to drive transferable contamination levels below the free release limits. Since several manufacturers offer strippable coatings as one of their products, selecting a half dozen for a side-by-side test was quite easy. As part of the LSDDP, the Savannah River Site entered into an agreement with Florida International University to perform a field test assessment of six strippable coatings in the 321-M Fuel Fabrication Facility. The strippable coatings selected are non-toxic and water-based, and contain no volatile compounds or heavy metals. The strippable coatings generate less secondary waste than conventional decontamination methods.

The non-liquid nature of the “cured” strippable coatings makes their handling and disposition less cumbersome.

Demonstration

Six new and improved strippable coatings were selected by Florida International University for the side-by-side test. Each strippable coating and its manufacturer/supplier are provided below:

Strippable Coating	Manufacturer/ Supplier
ALARA 1146	Williams Power Corporation
JDL#GP-RDM	FRHAM Safety
Tech Sol 8001	Technical Solutions
Tech Sol 8002	Technical Solutions
TLC Free	Bartlett Services, Inc.
Pentek	Pentek, Inc.

The coatings were sprayed onto four surfaces in the process area of the 321-M Facility. The coatings were sprayed onto a painted metal wall in the Log Storage Room portion of the Machining Room. The coatings were also sprayed on the Log Storage Room racks. In addition, the cylindrical canisters on a portable scrap cart were sprayed as well as the outer surface of the casting furnace enclosures. Figure 1 depicts an operator spraying the Log Storage Room wall.



Figure 1. Spray Application of Strippable Coatings

Primarily, the strippable coatings were tested for their decontamination capabilities. The coatings applied to the Log Storage Room walls were also tested for long-term durability. This test measured the temporary fixative nature of the strippable coatings.

The surfaces that were sprayed in the facility, ranged from low initial contamination levels (e.g., the Log Storage Room walls) to surfaces with higher levels of contamination (e.g., the log storage room racks and the casting furnace enclosures). WSRC and FIU engineers recorded the time taken to prepare for the demonstration, the initial condition of the candidate surfaces, the amount of coating material used per square foot of coverage, the ease of application, the ease of removal, the amount of labor required for the actual demonstration, the decontamination factor (DF) for each of the individual tests, and the weight of the stripped-off coating. Performance and cost data was then thoroughly analyzed.

The grand plan was to select the one or two best strippable coatings from the test assessment and use these coatings to decontaminate several more rooms in the contaminated portion of the facility.

Results or Future Plans

The early results from the demonstration show that the selected strippable coatings are effective in removing contamination from all surfaces that were tested. Results in other performance categories varied among the coatings. Some coatings were difficult to apply in uniform thicknesses on vertical and overhead surfaces, but performed satisfactorily in other categories. Each coating was evaluated against the identified performance measures. Performance results will be available from FIU when the compilation and analysis of the performance data is complete.

Long Range Alpha Detection

Statement of Facility Problem

During the operation of the 321-M facility, hundreds of miscellaneous items were subject to uranium contamination. Examples include lathe tools, machine parts, hand tools, pipe sections, pipe scaffolding, and fluorescent lights. Many items removed from the contamination area may not be contaminated and are candidates for free release. These items could be reused or buried as sanitary waste rather than low level waste if the absence of contamination is confirmed. Typically free release surveys are performed using hand probes and smears. This is a labor intensive task and is limited to surfaces accessible to probe and smear. Items with inaccessible surfaces, such as internal pipe surfaces, cannot be proven clean and released.

Description of Innovative Technology

The technology chosen for this demonstration is the BNFL Instruments IonSens™ Monitor. The IonSens™ System is an application of the Long Range Alpha Detection (LRAD) technology. Alpha particles are highly ionizing particles that lose their energy by creating electron/ion pairs in air. The ion pairs are transported by moving air to a collection grid. The collected ions create a current flow which is proportional to the alpha activity producing the ions. A detector unit measures the current and converts this electric signal into a number representing the amount of alpha contamination causing the ions.

The IonSens™ System is comprised of three modular units: an input filter unit, a component measurement chamber, and a detector unit. The measurement chamber can be either a Large Item Monitor (with an internal volume of one cubic meter) or a Cut Pipe Monitor (which is about two

meters long). Three Cut Pipe Monitor Modules can be used in series, providing the capability to monitor pipes and scaffold tubes up to 6 meters in length.

Demonstration

The IonSensTM System was used to monitor surface contamination levels on components (pipes and various other items) that were candidates for “free release”. Figure 2 shows the IonSensTM Monitor measuring potentially contaminated items from the 321-M Facility.



Figure 2. BNFL IonSensTM Monitor

The measurements using this technology were compared with the manual probe and smear baseline technology on the basis of cost, speed, reliability, and sensitivity. All items will be measured using both technologies to prove the accuracy of the IonSensTM System. Performance and cost data will be collected as a basis to evaluate the technology as an acceptable and permanent alternative to the hand probe and smear method for free release surveys.

Items of known contamination levels were introduced at random as part of the technology demonstration. Radioactive sources were also used to verify the sensitivity levels of the equipment.

Results or Future Plans

The LRAD technology demonstration was completed in January of 1999. Surveyed items consisted of pipe sections, hand tools, aluminum billets, florescent light bulbs, angle iron sections, and other miscellaneous items. Random hand surveys performed on items cleared by the IonSensTM System verified these items were below the free release limits. In a few cases, the IonSensTM System identified items as contaminated after initial hand surveys indicated no contamination. A comprehensive package of free release survey data will be available when the probe and smear measurements are complete.

X-Ray, K-Edge Heavy Metal Detection System

Statement of Facility Problem

From 1956 to 1992, the 321-M Facility fabricated fuel assemblies and extruded target assemblies for the SRS production reactors. The casting, machining, and cutting operations generated significant quantities of uranium dust. Over the years, accountable levels of highly enriched uranium (HEU) built up in the process area's ventilation exhaust systems and in specific pieces of process equipment. In September of 1995, U-235 holdup measurements were performed on the ventilation exhaust systems and selected pieces of equipment in the 321-M Facility. The measurements were taken with a collimated 2x2-inch NaI detector and summarized in Technical Report WSRC-TR-95-0492. Based on the results of this assay, the total quantity of U-235 in the facility was calculated to be 1218 grams. The relative uncertainty for this type of measurement is +100%, -50%. A more precise assay measurement was sought.

Description of Innovative Technology

The K-edge inspection technology is based on the measurement of the energy spectrum of an X-ray beam transmitted through a sample. The energy at which the abrupt change in transmitted intensity occurs identifies the type of material present. The amount of HEU present can be calculated based on the magnitude of the intensity change.

The X-ray, K-edge Heavy Metal Detection System consists of three major components: an industrial X-ray tube, a detection system consisting of an X-ray detector and an imaging system, and a data acquisition system consisting of a personal computer running a Windows-based user interface software that controls the X-ray generator, the detector, and the imaging system.

The X-ray tube and detection system are mounted on a customized support frame that can be easily manipulated to suit the configuration of the inspected object. The frame and its attached components is referred to as the inspection head. The inspection head is designed to position the X-ray tube on one side of the inspected object and the detector on the other side. The detection system consists of a high purity germanium (HPGe) crystal and a real-time X-ray imaging system. The HPGe detector and imaging system are mounted next to each other on a sliding platform that can be moved to center one system or the other on the X-ray beam.

The real-time X-ray image provides a quick qualitative indication of heavy metal location. The HPGe detector can then be positioned to obtain a precise measure of contamination. Both the X-ray source and the HPGe detector are collimated to define a narrow (<1 mm diameter) beam used to probe the sample material.

To minimize hazards to personnel, the X-ray source and detector package can be located some distance from the operator. The cooling and high voltage supply cart can be equipped with HEPA filters, and the X-ray source and detector can be wrapped in plastic to prevent the inadvertent contamination of this equipment.

In a typical application, a measurement accuracy of better than $\pm 20\%$ can be achieved within ten minutes. The technology demonstration goal is to achieve 10% precision.

Demonstration

The objective of the technology demonstration is to locate, and more accurately quantify, highly enriched uranium (HEU) inside selected 321-M Facility ventilation exhaust systems.

The first phase of the demonstration involves assaying the roof portion of the Lathe A Exhaust System and the Lathe B Exhaust System. This assay will be performed on the exhaust ducting up to the HEPA filters. The ducting is 12 inches and 18 inches in diameter. There are no interferences to contend with and a complete inspection should be possible. Figure 3 shows the x-ray, k-edge inspection head that will be used for the 321-M technology demonstration.



Figure 3. X-ray, K-edge Inspection Head

The second phase of the technology demonstration calls for an assay of two separate exhaust systems. Both systems are located inside the contaminated area. The Cooling Hut Exhaust System is in the Casting Room and services four components: the riser crusher, two gloveboxes, and a cooling hut. This system consists of 12-inch and 24-inch diameter horizontal ducting. There are interferences that must be removed for this demonstration. The Lathe Enclosures Exhaust System is in the Machining Room and services two components: the numerically-

controlled lathe (Lathe A) and the Gisholt lathe (Lathe B). These lathes have ventilation ducts that range in size from a 12-inch diameter to a 30-inch diameter. In addition to the ducting, both units have cyclone separators. The cyclone separators have holdup material in them and need to be assayed. There are interferences that must be removed for this demonstration.

Performance and cost data for the X-Ray, K-edge assays will be compared with the NaI assays performed in 1995.

Results or Future Plans

The x-ray, k-edge demonstration will occur in February and March of 1999. If the technology proves cost effective, this type of passive, non-destructive examination of heavy metal holdup material may be used on other Savannah River Site D&D projects. Field refinement of the innovative technology at SRS could lead to an expanded use of the technology throughout the DOE complex.

Asbestos Neutralization

Statement of Facility Problem

The 321-M Facility was built in the mid-1950s. During that time, material containing asbestos was commonly used in construction. The facility still has asbestos-lagged steam piping, asbestos-insulated ventilation supply ducts, and transite paneling. The facility's transite panels remain intact, have no visible signs of excessive deterioration, and have not been compromised by paneling cracks or holes. The 321-M deactivation project baseline makes no allowance for transite panel removal and disposition.

There is approximately 2200 feet of 321-M steam piping that is a candidate for the asbestos neutralization technology demonstration. This steam piping is not contaminated and does not have a metal jacket around it. The lagged lines are three and four-inch diameter steam pipes. The lagging is about three inches thick. The asbestos lagging is covered with a protective wrap. Most of the piping is above floor level.

Before a subcontractor removed it, there was 685 feet of thermally insulated ventilation supply ducting on the roof of the 321-M Facility. All but 80 feet of this ducting has been removed as part of the roof repair initiative. The ventilation supply line (which served the facility's manufacturing floor) is being left for the asbestos neutralization technology demonstration. This duct is about four feet square by 80 feet long and is covered with multiple layers of mastic and chicken wire that help protect the underlying asbestos insulation from the elements. The protective covering and underlying insulation is two inches thick.

If asbestos could be treated and made a benign material, it would not have to be removed. If asbestos could be left in-place, significant savings could be realized by avoiding the costly asbestos removal, handling, and disposal effort.

Description of Innovative Technology

Brookhaven National Laboratory (BNL) and W.R. Grace formed a partnership to explore asbestos neutralization technologies. The Asbestos Digestion Material, championed by BNL and WR Grace, converts chrysotile asbestos fibers from a hazardous, EPA-regulated material to a non-hazardous material. The fireproofing/insulation properties of the treated materials are retained. Samples pulled at the 321-M Facility in June of 1998 indicated an amosite asbestos problem as well as a chrysotile asbestos problem. Since the BNL/WR Grace chemical only neutralizes chrysotile asbestos, this chemical application could only solve half the problem. The solution was to go with a chemical application that could neutralize both amosite and chrysotile asbestos. Brookhaven National Laboratory has such a chemical, has submitted a patent on it, and is awaiting patent confirmation.

The BNL chemical will digest the asbestos fibers and convert all forms of asbestos to a non-hazardous material. BNL also has a novel analytical method for quantifying the remaining asbestos in a treated piece of material and proving the asbestos containing materials are at or below the 1% EPA limit.

BNL has recently received funding from the DOE Efficient Separations Program (ESP) Focus Area to support a comprehensive laboratory analysis of the neutralizing ability of the asbestos digestion chemical on the 321-M thermal insulation. In addition, a method for injecting the chemical through the mastic and tape barriers of both the steam pipe and ventilation duct lagging is a major obstacle still left to be solved. As part of this effort, a chemical delivery method needs to be developed and bench-scale tested. BNL is currently performing the laboratory analysis and working the engineering application problem.

If the results of this laboratory work are successful (referred to as Phase I), a small, in-situ demonstration will be conducted. If this demonstration is a success, the rest of the facility's insulation will be neutralized.

Demonstration

The delivery of the chemical to the underlying thermal insulation is the major obstacle to completing this technology demonstration. If this problem can be solved, a BNL representative will travel to SRS to perform a small scale demonstration on a 10 foot run of steam pipe and a 20 foot run of ventilation supply duct. The small scale demonstration constitutes Phase II of this technology demonstration. As part of this test, the area treated will be thoroughly sampled to verify that the neutralized material can meet the EPA criteria.

If the small scale demonstration yields a favorable outcome, the remainder of the ventilation supply line and most, if not all, of the 2200 feet of asbestos-lagged steam piping will be treated. The large scale application is Phase III of the technology demonstration.

Results or Future Plans

Phase I of the asbestos neutralization technology demonstration will be completed by the end of February. Phase II (the small scale demonstration) will be completed in April of 1999. Phase III (the large scale demonstration) is scheduled for the end of June.

If the BNL asbestos neutralization chemical and the associated chemical delivery technique prove successful, there could be a large payoff. No one questions the inherent hazards of asbestos containing materials or the difficulty of asbestos removal. If this material could be treated, made benign, and left in-place, the DOE complex and the commercial world would realize a windfall cost savings over the conventional method of handling asbestos problems and would reap the safety benefits of not having to deal with a hazardous material.

Thermal Spray Vitrification

Statement of Facility Problem

During the uranium metal casting and production activities in 321-M, a significant amount of highly enriched uranium (HEU) was carried over into the ventilation ductwork. Radioactive monitoring is required on a monthly basis to ensure that there are no releases from the contaminated equipment. The uranium is believed to be present as U_3O_8 , a totally oxidized form, and dust and dried lubricating oils may be present. A technique for recovering the HEU from the inside of ducts and equipment enclosures will allow the residual HEU to be removed from the facility. This in turn will remove the accountability requirements and will make it unnecessary to confine or stabilize the material in place. Active monitoring of ducts and equipment enclosures will no longer be required.

Description of Innovative Technology

The State University of New York at Stony Brook, NY (SUNY-SB), has developed a technique to thermally spray molten glass to safely remove lead paint from bridges, storage tanks, or other structures. This technique is called Thermal Spray Vitrification (TSV). SUNY, U.S. Army Corps of Engineers, and Zatorski Coatings, Inc., successfully demonstrated the technology on the Triborough Bridge in New York City. The demonstration utilized a low melting point glass composition developed by the Savannah River Technology Center (SRTC). The molten glass vaporized the organics in the lead paint and bonded the lead to the surface of the glass. As the glass cooled, it contracted and fell off the metallic structure, removing the contaminant of concern.

Demonstration

This same technology has been proposed to remove HEU contamination from the 321-M hoods and overhead ductwork. The proposed plan is to spray molten glass onto selected hood and ventilation duct contaminated surfaces. The goal is to clean the hood and duct surfaces to the non-radioactive release limits. Disposal of the decontaminated materials as sanitary waste, instead of low level radioactive waste, will result in substantial cost savings.

The mixture of U_3O_8 and dried lubricating oils should be much easier to remove from the metal surfaces than a thick latex or oil based lead paint. A low melting point glass is desirable to keep the oxyacetylene torch temperatures as low as possible. Upon application, the HEU will stick to the surface of the molten glass. When the glass cools, it spalls off, and the uranium should remain attached to the glass surface. This will minimize or eliminate the airborne uranium inhalation hazard, which is the main personnel concern in the decontamination of the facility's process equipment. The solidified glass will be collected, and representative samples analyzed for HEU accountability. The boron in the borosilicate glass frit will eliminate any criticality

concerns, allowing for reduced criticality control activities as compared to other removal techniques.

The actual demonstration is planned to be conducted in the 321-M Charge Preparation Room. The two process hoods, the vertical hood risers, the rectangular horizontal overhead duct, the ceiling penetration connector, and the round horizontal ductwork on the roof upstream of the HEPA filter bank will be decontaminated. This equipment has little enriched uranium, so there will be no criticality concerns with this initial demonstration. The technique of collecting and sampling the glass for accountability will be demonstrated. The efficacy and cost effectiveness will be compared to a baseline removal technique, and if successful, TSV could be used on facility equipment and ducts with more extensive uranium contamination.

Results or Future Plans

The thermal spray vitrification technique will be demonstrated early this summer. The project team feels TSV would be successful at decontaminating various metal and cement surfaces in other SRS surplus facilities. TSV could also be used on plutonium and transuranic (TRU) contaminated surfaces, as well as those surfaces contaminated with uranium.

Cutting/Size Reduction

Statement of Facility Problem

Many components in the contamination area that are to be removed and discarded are too large to fit into a B-12 or B-25 standard waste container. These items need to be cut to a smaller size, and in some cases, cut from their mountings. Examples are floor-anchored storage racks, hoods and gloveboxes, ventilation ducts, non-structural component supports, and carts that were used to transport product material.

Because of the contamination, it is necessary to avoid flame cutting or other techniques that could release airborne dust or vapors. A hydraulic shear is ideal, but shears large enough to cut the components in question are large, heavy, and difficult to operate by hand.

In addition, the 321-M Facility contains fixed equipment that will not be removed. A conventional hydraulic shear system (mounted on a powered vehicle like a Track-Hoe™ or Bobcat™) will not fit between installed equipment and is too large to pass through conventional doors.

To meet the facility's cutting/size reduction needs, the desired technology should be a medium size shear, with a long reach, that is mounted on a moveable platform that an operator could easily position. The device should also have a "local control" capability.

Description of Innovative Technology

A medium size shear, mounted on a manually-operated/hydraulically-assisted deployment platform, will be small enough to fit through a standard door. The shear deployment platform can be used with medium range shears weighing between 50 pounds and 150 pounds. The assist device consists of a hydraulic boom, with an up/down and in/out motion capability, with the shear mounted in a manually adjusted articulating-gimbal arm at the end of the boom. Because

the majority of the weight of the shear is supported by the articulating arm, very little physical effort is needed to make final orientation and location adjustments for the operation of the shear. The articulating-gimbal arm arrangement allows for shearing in unlimited directions.

Demonstration

The proposed system is capable of working in narrow aisles and small spaces, similar to the conditions found in the Charge Preparation Room, the Vault, the Casting Room, and the Machining Room of the 321-M Facility. Storage racks, product carts, and small gage components from the 321-M Facility's contaminated area will be cut and then size-reduced. Using this device, the dismantlement activity should speedup the cutting/size reduction process, minimize some of the industrial safety concerns, and bring the overheads into reach.

This technology will be compared to the use of handheld shears and porta-band cutting.

Results or Future Plans

This technology demonstration will not be completed until July of 1999. If the selected technology is relatively inexpensive, does not produce a spark or open flame during cutting operations, can be maneuvered in tight spaces, is easy to operate and maintain, can be quickly deconned, and is flexible enough to meet a variety of deactivation and decommissioning missions, future deployment is guaranteed.

Electret Ionization Chambers

Statement of Facility Problem

The 321-M Fuel Fabrication Facility was used to manufacture fuel elements for reactors. This involved precise weigh-out of aluminum and enriched uranium, melting them together into alloy, extruding the alloy into tubes, and various steps involving machining, welding, and chemical cleaning. These activities contaminated many areas and components with uranium. The Machining Room and the Casting Room are the two most contaminated rooms in the facility.

Facility overheads include: conduit, piping, cable trays, cabling, piping and conduit support framework, ledges, etc. The overheads in the Machining Room and the Casting Room may be contaminated with uranium dust. To determine the contamination status of the overheads in these rooms a labor intensive survey of the entire overhead would need to be completed. A less cumbersome survey approach is desired.

Description of Innovative Technology

The innovative technology chosen for this demonstration uses electret ionization chambers (EIC), which consist of a charged Teflon plate (the electret) and an electrically conductive plastic chamber. The electret is charged using a special process that allows it to retain its electric charge for extended periods of time. The electrets are initially charged by the manufacturer to a surface voltage of 700 volts (positive charge). Prior to measuring contamination levels, the electrets are placed in the surface voltage reader to obtain the initial voltage. The electret ionization chamber can then be placed on the contaminated surface to be measured. Alpha particles that enter the chamber ionize the air in it, and the stripped electrons are attracted to and deposited on the electret, thus reducing the electret's surface charge. The drop in the electret's voltage is a

measure of the amount of ionizations during the measurement period. Appropriate calibration factors are used to convert the rate of change in the surface charge to alpha activity. Given the footprint of the electret ionization chamber, an alpha surface contamination level can be determined. Surface contamination levels can be compared to the uranium free release limits to determine the overheads' contamination status.

Demonstration

The electret ionization chambers will be placed throughout the Machining and Casting Room overheads. The placement of the ionization chambers will be driven by a statistically-derived sample plan. Based on the facility's past operating history, the overheads are potentially contaminated. The expectation is that most of the overheads in these rooms are still below the uranium free release limits. If the sample plan is correctly developed, the results could prove, to a 95% confidence level, that all surface contamination measurements fall below the uranium free release limits.

The electret ionization chambers could also be used to monitor surface contamination levels on hundreds of small components that are candidates for "free release". These readings could be compared to probe and smear measurements and to the LRAD measurements.

As part of the technology demonstration, the overheads (and small items if this portion of the demonstration is pursued) will be measured using electret ionization chambers and the manual probe and smear technique. For this demonstration, the manual probe and smear method is the baseline approach. The performance and cost data from the electret ionization chambers will be compared to the performance and cost data from the manual effort. The analysis of this data should prove the accuracy and precision of the electret ionization chambers. The superior MDA (minimum detectable activity) of the electret ionization chambers should also be highlighted.

Results or Future Plans

This technology demonstration will be completed in April of 1999. Results of the technology demonstration will be provided at a later date.

SUMMARY

The technologies demonstrated in the 321-M Facility will help reach end points identified in the facility's deactivation plan. For example, a strippable coating will be used to decontaminate the walls and floor of the Charge Preparation Room and the Vault. Although confirmatory probe and smear measurements were required to free release items analyzed by the long range alpha detector (LRAD), significant progress was made in getting LRAD accepted as a replacement for the manual method of determining small item contamination levels. The X-Ray, K-Edge Heavy Metal Detection System is a more accurate alternative to portable NaI detectors. The x-ray, k-edge device will be used to characterize several facility ventilation ducts. Characterization of HEU in the facility ventilation ducts is essential to developing and implementing an HEU removal plan. If the asbestos neutralization demonstration proves to be successful, the project team could move to neutralize all asbestos-insulated steam pipes in the building. Thermal Spray Vitrification (TSV) is an innovative decontamination approach. The proposed plan is to decontaminate the process hoods and ventilation exhaust system in the

Charge Preparation Room. Another deactivation end point that will be pursued is the removal of loose, and some fixed, components and equipment in the facility. A cutting/size reduction device is being competitively bid. It will be used this summer to clear out the CA. Finally, electret ionization chambers will be used to characterize the facility overheads.

The 321-M LSDDP will complete all field demonstrations by September 30, 1999. All Innovative Technology Summary Reports will be completed and submitted to DOE-FETC by the end of the calendar year.