ABSTRACT

The United States Department of Energy (DOE) and commercial nuclear utilities are the two major owners of radioactively contaminated facilities requiring decommissioning. DOE, the Electric Power Research Institute, and several nuclear utilities in the United States recognized that DOE and the nuclear utilities share common problems in decommissioning of their excess facilities and power plants. These organizations also recognized the benefit of jointly working on these common problems. As a result, they established a DOE/Utility Decontamination and Decommissioning (D&D) Consortium to jointly develop, demonstrate, and deploy improved technologies that are beneficial in decommissioning of excess radioactivity-contaminated facilities within DOE and shutdown nuclear power plants.

INTRODUCTION

The United States Department of Energy (DOE) and commercial nuclear utilities are the two major owners of radioactively contaminated facilities requiring decommissioning. DOE, the Electric Power Research Institute, and several nuclear utilities in the United States recognized that DOE and the nuclear utilities share common problems in decommissioning of their excess facilities and power plants. These organizations also recognized the benefit of jointly working on these common problems. As a result, they established a DOE/Utility Decontamination and Decommissioning (D&D) Consortium to jointly develop, demonstrate, and deploy improved technologies that are beneficial in decommissioning of excess radioactivity-contaminated facilities within DOE and shutdown nuclear power plants.

COMMON PROBLEMS

There are 442 commercial nuclear power plants worldwide of which 109 are located in the United States. The figure below shows the "End of Licensed Life" date for the current 109 commercial nuclear reactors in the United States. Due to deregulation, electric utilities must make difficult decisions on whether to extend the operating licenses or to decommission the plants when these nuclear power plants reach the end date of their current licenses. Economic, environmental, and stakeholder factors must be considered in making these decisions.
About ten nuclear power plants are currently being decommissioned or will soon begin decommissioning. Several more nuclear power plants are expected to enter decommissioning in the next ten years. The current estimated cost to decommission a nuclear power plant is about $500-550 million, which includes the cost of temporary storage of spent fuel until the DOE geological repository opens sometime in the 2010-2016 period. Therefore, the cost to decommission the 109 nuclear power plants in the United States is estimated to be approximately $54-60 billion.

The estimated cost to decommission excess facilities that are currently in DOE’s Environmental Management Program is about $14 billion. About two-thirds of this work will occur before 2006, while one-third will be completed before 2006. It is estimated that there is another $25 billion in facility deactivation and decommissioning costs for those facilities that will be declared excess and transferred from other DOE programs such as Science, Nuclear Energy, and Defense Program to DOE’s Environmental Management program. Therefore, the cost to decommission DOE’s excess facilities is approximately $39 billion (1).

As described above, the decommissioning markets for both DOE and the nuclear utility industry are similar with both being in the tens of billions of dollars. The challenges facing DOE’s decommissioning program are more diverse than the power plants owned by the nuclear facilities since DOE owns a greater variety of excess facilities with a wider range of contaminants including production reactors, research reactors, fuel reprocessing canyons, weapons components fabrication and assembly facilities, plutonium gloveboxes, laboratories, plutonium tritium facilities, lithium facilities, and gaseous diffusion plants. Nevertheless, the problems and technological solutions associated with decommissioning DOE’s production and research reactors have direct application in decommissioning of nuclear power plants and vice versa.

**LARGE-SCALE DEMONSTRATION AND DEPLOYMENT PROJECTS**

DOE’s Deactivation and Decommissioning Focus Area (DDFA) has initiated a series of Large-Scale Demonstration and Deployment Projects (LSDDPs) and currently there are seven LSDDPs.
In LSDDPs, potential improved D&D technologies are demonstrated and evaluated alongside competing baseline technologies in DOE’s ongoing deactivation and decommissioning projects. Typically, the technology demonstrations have occurred in the areas of facility characterization, material decontamination, facility dismantlement and demolition, waste management, and personnel safety. The U.S. Army Corps of Engineers provides an independent cost analysis comparing the improved D&D technologies to the baseline technologies using performance data collected during the demonstrations. Through September 2000, the DDFA has conducted 93 technology demonstrations in the LSDDPs and 52 of those technologies have subsequently been deployed 259 times. Average cost savings of the improved D&D technologies compared to the baseline technologies has been 20 to 40%, but several improved D&D technologies have shown cost savings in excess of 90%. Based on these results and implementation of the improved D&D technologies, the DDFA expects to reduce DOE’s decommissioning costs prior to 2006 by 25%. In anticipation of technology breakthroughs arising from DOE’s basic science program, the DDFA expects to reduce DOE’s decommissioning costs after 2006 by 50%. Based on implementation of these improved D&D technologies, the cost to decommission nuclear power plants in the utility sector is expected to be reduced by at least 25%, but probably not as great as 50%. Both DOE and the nuclear utilities will benefit from improved technologies demonstrated in the LSDDPs.

HISTORY OF DOE/UTILITY D&D CONSORTIUM

In December 1997, DOE signed a Memorandum of Understanding (MOU) with the Electric Power Research Institute (EPRI) and several nuclear utilities to jointly develop, demonstrate, and deploy improved D&D technologies in ongoing decommissioning projects within DOE and the nuclear utility industry. The MOU established the initial membership of the DOE/Utility D&D Consortium. The Consortium established its charter in early 1998 and held a road-mapping workshop to identify challenging technological areas common to both DOE and the nuclear utility industry. The MOU established a mechanism to facilitate the exchange of best business practices and lessons learned, and to plan and execute a leveraged technology program which meets the D&D technical needs of both DOE and the commercial nuclear utilities.

The current members of the DOE/Utility D&D Consortium are:

- DOE National Energy Technology Laboratory (NETL)
- Deactivation and Decommissioning Focus Area
- Electric Power Research Institute (EPRI)
- Commonwealth Edison (ComEd)
- Duke Engineering & Services (Duke Energy)
- Consumers Energy Company
- Yankee Atomic Electric
- General Public Utilities
- Argonne National Laboratory
- Florida International University
- Sacramento Municipal Utility District (Rancho Seco)
- Portland General Electric (Trojan)
The main benefits of the DOE/Utility D&D Consortium are:

- Cost sharing reduces the cost to implement new and improved D&D technologies within DOE and the nuclear utilities
- Reduces decommissioning costs for ratepayers of electric utilities owning nuclear power plants and the taxpayers that fund DOE’s decommissioning program
- In addition to cost reduction, deployment of improved D&D technologies will improve safety, accelerate D&D schedules, and reduce radiation dose to workers
- Mechanism to share information on improved D&D technologies
- Opportunities to demonstrate and deploy improved technologies within DOE and the nuclear utilities

CONTACTS

DOE’s Deactivation and Decommissioning Focus Area sponsors the world’s largest D&D technology program and is the primary DOE representative on DOE/Utility D&D Consortium. The DDFA program is funded through DOE EM’s Office of Science and Technology (OST) and is located at the National Energy Technology Laboratory in Morgantown, West Virginia and Pittsburgh, Pennsylvania. The DOE’s DDFA representative on the DOE/Utility D&D Consortium is:

Nelson Rekos, DOE-NETL (304) 285-4066, E-mail: nelson.rekos@netl.doe.gov

The Electric Power Research Institute (EPRI) is the primary utility representative on the DOE/Utility D&D Consortium. EPRI has an active D&D program to support its member utilities owning shutdown nuclear power plants. The EPRI representative on the DOE/Utility D&D Consortium is:

Bob Thomas, EPRI (650) 855-2047, E-mail: rothomas@epri.com

ACCOMPLISHMENTS

Workshops:

DOE and EPRI are jointly sponsoring quarterly workshops held at various nuclear plants around the country. Each workshop has focused on a specific topical area relevant to decommissioning of radioactively contaminated facilities. These workshops have allowed DOE and the utilities to openly share technology information. The following is a list of workshops conducted through February 2001.

- Southern California Edison (San Onofre, Unit 1)
- Pacific Gas & Electric Co. (Humbolt Bay)
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<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>LOCATION</th>
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<tbody>
<tr>
<td>Sep 1998</td>
<td>Concrete Decontamination</td>
<td>Yankee Rowe</td>
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<td>Dec 1998</td>
<td>EPRI/NEI Planning and Technology Forum</td>
<td>Monterey, CA</td>
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<td>Feb 1999</td>
<td>Embedded Piping Decontamination, Tank Remediation, and Fuel Pool Cleaning</td>
<td>Trojan</td>
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<td>May 1999</td>
<td>Site Characterization and Final Release Survey</td>
<td>Oyster Creek</td>
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<td>Aug 1999</td>
<td>Hazardous Waste Material Remediation Technology</td>
<td>Big Rock Point</td>
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<tr>
<td>Oct 1999</td>
<td>EPRI/NEI Planning and Technology Forum</td>
<td>Portland, ME</td>
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<td>Mar 2000</td>
<td>Radioactive Low-Level Waste Management</td>
<td>Rancho Seco</td>
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<tr>
<td>Jun 2000</td>
<td>Decontamination and ALARA Worker Safety</td>
<td>Maine Yankee</td>
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<tr>
<td>July 2000</td>
<td>EPRI/NEI Planning and Technology Forum</td>
<td>Newport Beach, CA</td>
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<tr>
<td>Oct 2000</td>
<td>Plant Reconfiguration and Engineering Processes</td>
<td>Millstone</td>
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**DEMONSTRATIONS**

Three technologies were successfully demonstrated at two different Utility site locations.

The first technology demonstrated in March 2000 was at Rancho Seco and involved the concrete shaving technology developed by Marcrist Industries, Limited and licensed by Bluegrass Concrete Cutting, Incorporated in the United States. The shaving technology results in relatively smooth finish that facilitates post decontamination surveys as well as has the ability to shave surfaces containing embedded metals. Two separate pieces of equipment were demonstrated and both used a diamond-impregnated shaving drum as the cutting tool for removal of the concrete surface. Generated dust was collected by a vacuum system and deposited in a waste drum. The first piece of equipment was a self-propelled, electric powered floor shaver. It was demonstrated on clean and radioactively contaminated floor areas in the reactor turbine building. The second piece was a hydraulically powered wall-shaving unit. For purposes of the demonstration, the wall-shaving unit was mounted on a forklift. Operating staff from Rancho Seco were impressed with the results of both demonstrations and are considering using the technologies in their decommissioning project.
Functions on floors or walls
Adjustable depth of cut controls depth of contamination removal yet minimizes waste
Vacuum system effectively handles generated dust
Equipment easy to decontaminate and clean

The second technology demonstrated at Rancho Seco was the Online Decontamination Unit in May 2000. The demonstration involved the Online Decontamination Unit developed by the Hemispheric Center for Environmental Technology at Florida International University (FIU-HCET). The Online Decontamination Unit integrates an online measurement system with a shot-blast concrete cleaning machine. The system provides a rapid way to decontaminate concrete floors when surface and near surface contamination is present. The measurement system allows the machine operator to observe the contamination removal by watching readout mounted on the machine and to adjust the speed and depth of removal based on these readings. The unit was demonstrated to clean a contaminated area and to record pre- and post-decontaminated data. The Online Decontamination Unit was successfully demonstrated and its integrated components functioned as expected.

Successful decontamination and characterization of concrete surfaces
Minimizes worker exposure to contaminated floors
Minimizes process time for “free-release” of floors by using “real-time” measurements of contamination

The third technology demonstrated was at Big Rock Point in April 2000 (3). The technology deployed was the Mobile Pipe Decontamination and Characterization System (MIP-DC) developed by FIU-HCET. The equipment is modular and requires minimal setup at the remediation site and standard mobile utility sources are used to power the system. This system cleans the interior and exterior of piping using shot blast and characterizes the pipe for free release. The piping demonstrated was 8-inch diameter carbon steel pipe and 17-inch diameter stainless steel pipe. The pipes processed ranged between 5 to 7 feet in length. Results indicated that pipes were cleaned to free release limits. Based on the results of this demonstration FIU-HCET is modifying the system to improve the throughput rate and economics of the system.
• Four modules for decontamination, ventilation, characterization, and offloading
• Demonstrated ability to clean inside and outside of pipes to free release limits
• Verified integration decontamination and characterization systems

CONCLUSION

The DOE/Utility D&D Consortium is continuing to sponsor Technology Exchanges, Workshops, and Technology Demonstrations and Deployments. The Consortium intends to increase the number of improved technology demonstrations and deployments in decommissioning projects at nuclear power plants and DOE. These demonstrations and deployments are modeled after the DDFA’s Large-Scale Demonstration and Deployment Program, which has been successful in demonstrating 93 technologies in DOE’s deactivation and decommissioning projects. Based on the successful results of most of these demonstrations, 52 technologies have been subsequently deployed over 259 times.

REFERENCES

3. EPRI Newsletter, Decommissioning Technology Update, January 2001