Innovative technology showcased for mobile radioactive source recovery

May 2 2023

Inside the mobile hot cell. Credit: Idaho National Laboratory

A crowd gathers around a black wooden box that resembles a short refrigerator, waiting for the motion of a pair of robotic arms sitting just outside the box. When the arms move, a wave of excited energy in the

room at Idaho National Laboratory conveys how this simple action may alter the future of international radioactive source removal and disposal.

The team was observing the first demonstration of a mobile hot cell that could fundamentally change how a certain class of radioactive materials is handled. The robotic and mobile nature of the hot cell is poised to improve economics, employee safety and national security.

"In some of the areas where we plan to use this mobile hot cell, radioactive sources are just left on the shelf once they've been spent, where they are extremely vulnerable to theft and producing harmful emissions," said Kathy McBride, the project manager for INL's Radioactive Source Recovery Project. "Having access to a proper disposal method could be a game-changer for many of these facilities and their staff."

What is source recovery?

Across the world, radiological materials play an important role in medical research and commercial facilities. If these radioactive sources were to fall into the wrong hands, they could be used in a radiological dispersal device (dirty bomb) or in other acts of terrorism. Safe removal of used radioactive sources requires new techniques and fabricated containers, which expand secure transportation opportunities.

The National Nuclear Security Administration's Office of Radiological Security (ORS) has funded INL's efforts to develop a mobile hot cell.

"Our job is to recover used, abandoned and unwanted radioactive sources," said Kevin Kenney, the relationship manager for INL's Radioactive Source Recovery Project. "We've already been doing domestic removals. However, this hot cell will enable our program to take these efforts internationally."

The mobile hot cell can be controlled and monitored from the outside, behind plenty of shielding. Credit: Idaho National Laboratory

Why a mobile hot cell?

This mobile hot cell project began about two years ago, with the goal of fabricating a first-of-its-kind mobile source recovery tool, or hot cell. ORS leaders hope to use this tool to reduce global radiological threats by providing tools and expertise to help international partners improve radioactive source end-of-life management. While standards for safely recovering and handling radioactive sources are strict in the United States, many other countries do not apply the same rigor.

As Kenney described it, the hot cell's mobility is more like a carnival than a recreational vehicle. It is designed to be assembled and shipped in multiple pieces, which are created with maximum shipping weights in mind. The shielding walls are constructed like a Russian stacking doll, with between four and five walls of increasing size that can be added or removed as necessary based on the maximum source activity of the irradiators.

"Another thing that distinguishes this from traditional hot cells is that it uses robotics, as opposed to manipulator arms," said Ted Reed, a mechanical engineer on the project. "This way, we can position our operators 50 feet away from the hot cell." This distance allows for reduced shielding needed to protect source handlers, decreasing the weight of the cell and to follow principles for handling radioactive material.

Improvements ahead

Although it's a vast improvement to current methods, the robot is still not perfect. Its joints can be damaged and rendered inoperable from the radiation of the sources. To mitigate this issue, the source recovery team prefers to preprogram the robot to perform discreet tasks, lessening the time it must spend moving around inside the hot cell.

At the end of September 2022, the team demonstrated a mock-up of the mobile hot cell with all of its components in place. The mock-up will be used to evaluate and optimize the design features over the next year.

At the demo, members of the Source Recovery team could see inside the mobile hot cell. Credit: Idaho National Laboratory

Already, INL's hot cell's design stands out. Current designs use sand for shielding, which requires significant effort to set up and tear down. Because hot cell operators can stand a safe distance away from a source with INL's design, the mobile hot cell enables a safe, rapid deployment.

Additionally, the mobile hot cell will allow radioactive sources from multiple devices to be prepared for consolidation into a single cask for transportation. This is a vast improvement over the current recovery method. It will minimize the resources required to complete any source recovery trip to remove several distinct devices from a country's inventory.

What's next?

During fiscal year 2023, the research team will finalize the design and it will undergo safety analyses. If all goes well, the hot cell will be demonstrated and deployed both internationally and domestically.

"Occasionally, we will encounter an irradiator in the U.S. that can't be shipped in a cask due to limits on the amount of material that can ship at once," Kenney said. "That's another case where it would be essential to have a mobile hot cell that can be deployed."

Eric Egan, the principal investigator within the source recovery team for the mobile hot cell project, emphasized the team effort required to complete this project. "This impressive accomplishment would not have

been possible without support from inside and outside INL. This includes the technical expertise and advice from Southwest Research Institute, as well as the invaluable skill of our INL machinists, facility and nuclear safety engineers."

Provided by Idaho National Laboratory