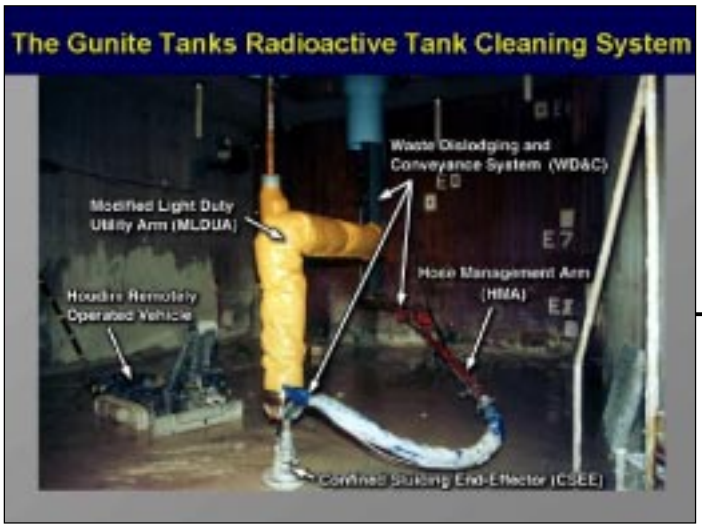

A DOE SUCCESS: Cleaning of Gunite and Associated Tanks at the Oak Ridge National Laboratory

The Project: The Gunite and Associated Tanks (GAAT) are located at the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. Constructed in the early 1940's, the tanks collect, neutralize, store, and transfer liquid radioactive and/or hazardous waste. These tanks contain the largest inventory of underground contaminants in the main ORNL plant area and have been identified as a high priority for clean up. The goal of the remediation project has been to remove the waste and stabilize the tanks in order to protect workers, the public, and the environment.

Beginning in 1997 and continuing on through the fall of 2000, several remote technologies have been integrated and implemented to remove wastes from GAAT.

An advanced waste removal technology known as confined sluicing has been implemented to remove waste from the tanks. The Department of Energy Office of Science and Technology Tanks Focus Area developed this technology. Confined sluicing consists of a "vacuum cleaner" type head, or end effector, which utilizes a high pressure water cutting jet to loosen sludge from the tank bottoms. The end effector is attached to a hose controlled by the Hose Management Arm.

A water jet pump removes the sludge and liquids from the tanks. The confined sluicing end effector is moved around inside the tanks by two remotely operated systems. Overview cameras in the tanks and cameras located on the robotic arm and vehicle provide equipment operators a view of the tank interiors and waste removal activities.

The Modified Light Duty Utility Arm (MLDUA) that has been in continuous operation at ORNL since delivery in November 1996, is a robotic arm used to maneuver retrieval equipment throughout the Gunite Tanks. SPAR Aerospace, Ltd., with technical direction from the TFA and the Robotics Crosscutting Program (RBX), manufactured ORNL's MLDUA for the increased reach and higher payload capability necessary to aid in sludge removal from the Gunite Tanks. The MLDUA is one of four Light Duty Utility Arm (LDUA) systems that were developed as part of a collaboration involving 5 DOE sites. A truck-mounted LDUA system that was delivered to Hanford has been deployed for tank inspection and a skid-mounted version that was delivered to INEEL has been deployed in several tanks for sampling and inspection.

The Houdini-II robotic vehicle was produced by RedZone Robotics, Inc. for the RBX. It was designed to maneuver the confined sluicing end effector and to scrape sludge from the tank bottoms. The vehicle has the ability to fold up, allowing it to fit though the 24 inch diameter risers that permit access to the Gunite Tanks. Inside the tank the vehicle opens up to a 4 x 5-foot platform that includes a plow, robotic arm, camera, and other equipment, which can be utilized during sludge retrieval operations.

The Impact: Implementation of these remote systems has resulted in significant cost and schedule savings. The GAAT Remediation

Project is currently on track to complete waste removal approximately thirteen years ahead of original schedule estimates and $121 million under initial cost estimates.

Waste retrieval operations have been completed in five underground storage tanks. Operations are currently underway in a sixth tank while retrieval from the seventh and final tank is scheduled for completion by the end of FY 2000.

Further Advances through a RIM Initiative:
The remote systems deployed at GAAT provided good remote functionality and removed workers from the hazardous environment; but with the exception of the MLDUA, these systems were fundamentally teleoperated systems with little or no automated capabilities. The RIM initiative could provide technology to increase the level of automation within these systems thereby increasing the efficiency and productivity. Coordinated motion of multiple cooperating robots of different designs is needed to improve waste retrieval efficiencies. Perception, planning, and advanced controls technologies permitting task completion on terrain with minimal distinguishing features and high slippage rates would release operators from tedious activities and allow autonomous operation of the Houdini vehicle. Supervisory control would allow a single operator to manage a team of robots, such as the MLDUA and Houdini, reducing the need for multiple operators.

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