

AVANTech Fully Automated Fill-Head and Dewatering System (Featuring Robotic Arm Technology)

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Overview

Case Study – URV™/REDE System at Perry Nuclear Power Plant

- FirstEnergy purchased the AVANTech Ultra-Rapid Vacuum (URV™) with Remote Engaging/Disengaging (REDE) Fill-Head featuring spherical configuration robotic arm technology for dewatering/drying containers at the Perry Nuclear Power Plant in Perry, Ohio, USA.
- The URV™/REDE System provides an efficient means of remotely dewatering and drying steel liners, High Integrity Containers (HICs), and other waste containers to comply with waste disposal site acceptance criteria for Free Standing Liquid (FSL).
- Installation was performed in mid-April through early May 2018. Site Acceptance Testing was completed on May 11th, and waste transfer was completed on May 16th.
- All operations were performed remotely: fill-head to liner engagement, waste transfer, gross dewatering, media drying, and fill-head removal. No entry to the High Radiation Area/Locked High Radiation Area (HRA/LHRA) was needed during any phase of the process.

URV™/REDE System Main Components

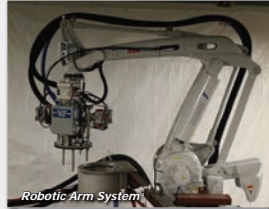
- Main Control Panel (MCP)** – Contains all remote controls for final robotic fill-head placement, monitoring of waste transfer, color closed-circuit television (CCTV) system with multiple cameras, and programmable logic controller (PLC) with full system operability of all remote components, as well as system warnings and alarms with logic initiated system shutdowns.
- Robotic Control Panel (RCP)** – Power supply and back-up controls to robotic arm, allows operation in automatic or manual mode, ability to respond and recover from robotic system warnings and alarms.
- Robotic Arm and Fill-Head** – Remote engagement/disengagement of fill-head to waste container.
- Dewatering/Drying Skid** – Gross dewatering of waste container during waste transfer and final drying to disposal site waste acceptance criteria for direct disposal; operated remotely from MCP.
- Waste Inlet Manifold** – Interface with plant waste discharge to fill-head, provides redundant overflow protection, allows system flushing to/from plant connection after transfer is complete.
- Remote Control Console (RCC)** – Allows system control from remote location of user's choice, controls all system functions except robotic arm control; touchscreen interactive panels utilized for operator control.

URV™/REDE System Operation

Robotic Arm Fill-Head Positioning

- The Robotic Arm System is programmed to maneuver to three separate positions (additional positions can be programmed as desired by the customer):

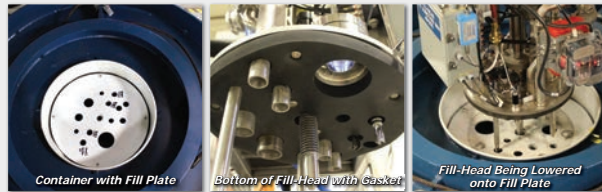
- Home:** Fill-head stand/containment pan
- Process:** The opening on the dewatering container
- Maintenance:** The low-dose area for preventative maintenance



- For the fill-head installation, the robot is programmed to go to the "Process" position and will come to approximately 4 inches above the container opening and stop, awaiting the operator to take over control for final positioning and sealing to the container.

Remote Engaging/Disengaging (REDE) Fill-Head



- The fill-head assembly is lowered onto the container and the fill-head engagement mechanism is activated to seal the fill-head to the container fill plate.
- After the container is filled with waste and dewatered, the fill-head is ready to be removed. The operator instructs the robot to return to the "Home" position and the fill-head is secured in its fill-head stand/containment pan.
- There are multiple system interlocks between system components. For example, when the fill-head is disengaged from the container, the waste transfer inlet valves become inoperable.



URV™ System Dewatering/Drying

- Remote Filling/Dewatering Operation** – All waste control valves, dewatering valves, and air-operated diaphragm (AOD) pump are controlled remotely.
- Standard Dewatering System (SDS) for Gross Dewatering** – Gross dewatering is necessary during waste slurry transfer to remove excess water used to enhance media movement. SDS is used to remove a large volume of water quickly during the waste slurry transfer process and dewater the waste container to approximately 1-2% FSL.
- URV™ for Final Drying of Waste Disposal Containers** – If the container will be shipped for direct disposal, the URV™ system is used to reduce residual FSL to less than 1.0% by volume, in compliance with the US commercial waste disposal site acceptance criteria.
- Final Drying** – After gross dewatering, the vacuum pump is started to recirculate warm air through the container. As the warm air passes through waste media in the container, it entrains water vapor, which is then routed through an ejector venturi and demister where the entrained water is condensed in the demister tank.
- Conditioned Air Recirculation** – Excess condensed water is removed from the tank by the condensate pump and auto drain valve. The conditioned air is then routed back through the vacuum pump and to the container in a closed loop.

URV™ Dewatering/Drying Performance

	Granular Media (Bead Resin)	Powdered Media (Powdex)
AOD Gross Dewatering	1 hour	2 hours
URV™ Vacuum Drying	4 hours	8 hours
Total Time for Dry Media	≤5 hours	≤10 hours
Dried Media Results		

URV™/REDE System Advantages

- ALARA Remote Operations** – The entire URV™/REDE System is remotely operated from a low dose area. The MCP and RCC can be situated anywhere in the processing area or adjacent rooms.
- Excellent Visual Monitoring** – A high-resolution camera (rad hardened to 1x10⁴) with a wide field of view provides total system control and monitoring of the inside of the container. The visibility afforded by the camera of the container internals allows incorporation of a graduated measuring rod to permit the operator to maintain control of the container filling operation.
- Automated HMI/PLC Control System** –
 - HMI allows for real-time monitoring of system components and parameters.
 - Multiple PLC interlocks with system components for safer operations.
 - Allows for safe shutdown during abnormal conditions or loss of power.
 - Mitigates possibility of over-flow conditions.
- Designed to Meet Disposal Site Waste Acceptance Criteria** –
 - Direct burial eliminates the need for additional shipping/processing fees.
 - Bead resin, granular media in ≤5 hours
 - Powdered resin in ≤10 hours

