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DEMONSTRATION OF AUTOMATION TECHNOLOGY FOR NUCLEAR MATERIALS HANDLING

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INTRODUCTION

In anticipation of increased dispositioning of surplus nuclear material, improved operational efficiency and reduced worker radioactive dose are priority targets for technological innovation. The use of automation to perform traditionally manual tasks presents great opportunity to satisfy these needs.

Savannah River National Lab's (SNRL) Research and Development Engineering (R&DE) organization recently developed and demonstrated automated technologies that show great promise in the safe and efficient handling of nuclear materials.

MATERIAL PACKAGING: THE 3013 AND THE 9975

At SRS, one type of container which stores Special Nuclear Material (SNM) is a stainless-steel canister called a 3013. The 3013 container is stored within a 9975 Package. The 9975, shown in Fig. 1, consists of an external steel drum, insulation, and multiple concentric containment vessels.

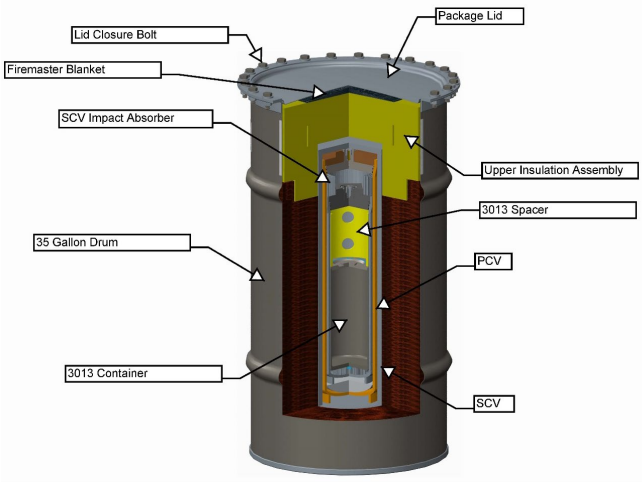

Fig. 1. 9975 Package Cutaway Diagram.

AUTOMATED GUIDED VEHICLE (AGV)

An Automated Guided Vehicle (AGV), which is a driver-less fork truck, was used to handle pallets of 9975 packages. Pallets of four 9975s were retrieved and delivered by the AGV to a robotic workstation for inspection and processing.

TABLE I. AGV Capabilities

Lift Capacity	909 kg
Lift Height	1219 mm
Guidance	LIDAR
Positional Accuracy	± 6 mm

An operator instructs the AGV via computer workstation to retrieve a pallet from one predefined location and to deliver it to another predefined location.

A Pan, Tilt, Zoom (PTZ) video camera was installed by SRNL R&DE to provide operators real-time visual feedback of the AGV's operation.

Fig. 2. AGV handling a pallet of 9975 packages.

INDUSTRIAL ROBOT

The robot used for this demonstration is a FANUC R-1000iA/100F with FANUC iRVision system (3D machine vision) and a R-30iB Controller. The R-1000iA/100F is a six-axis industrial robot typically used for material handling and welding operations. General specifications for the robot are shown in Table II:

TABLE II. Robot Capabilities

Reach	2230 mm
Lift Capacity	100 kg
Maximum Speed	2000 mm/s

The use of an industrial robot allows for precise and repeatable operations.

Fig. 3. Robot with various EOAT and 9975s.

END OF ARM TOOLING (EOAT)

To disassemble a 9975 package and retrieve the 3013 cannister within requires the use of eight (8) individual EOATs. The tooling consists primarily of grippers of various sizes and orientations suited to manipulating and removing an array of specific components. A Schunk SWA-076 quick tool change adaptor allowed the rapid and accurate exchange of end of arm tools on the robot. The tool change adaptor features pneumatic passthroughs, allowing for tooling to utilize actuators and vacuum cups.

Fig. 4. Vacuum Gripper EOAT removing 9975 lid.

WORK CELL EQUIPMENT

Ancillary equipment was used in the area surrounding the robot to facilitate the tasks the robot performed. Of particular importance were the Containment Vessel (CV) Rotator, and the EOAT Table.

The CV Rotator's purpose was to unscrew the cap of the Containment Vessel. The CV Rotator consisted of a motorized turntable and a pair of vertical guideways. The motorized turntable would rotate the body of the CV while a custom EOAT would act as a wrench preventing the lid of the CV from rotating. This action resulted in the CV's lid being unscrewed from the body, thus opening the container for further processing.

Fig. 5. Containment Vessel Rotator.

Another important component in the work cell was the EOAT Table. The Table consisted of supports and fixtures which would accurately locate the eight (8) EOATs. The robotic system's continual need for switching End of Arm Tools required that each tool be in a known and accurate location. The table fixtures provided a reliable and non-damaging way of holding and storing tools while not in use. The fixtures were primarily made of additive manufactured plastics.

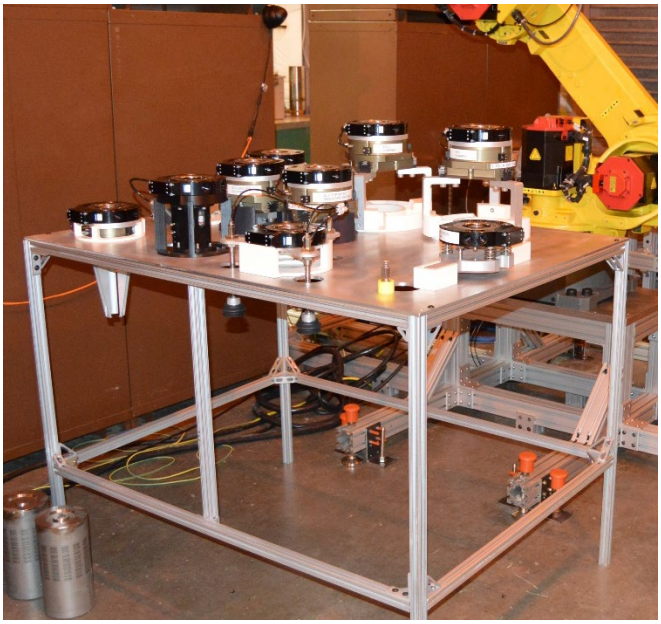

Fig. 6. End of Arm Tooling Table.

CONTROL SYSTEM

A central operator workstation was set up for overall system monitoring. For the purposes of the 9975 Handling Automation Demonstration, not all automated systems and functions were integrated into a single interface controller, but for permanently installed systems, this would be the case. An operator in the central workstation would be able to control the AGV, the robot, and review/approve automated part inspections.

RESULTS

The demonstration of the automated 9975 handling system showed that automation can reliably, efficiently, and safely perform many of the tasks associated with retrieving and disassembling nuclear material packaging. The use of such equipment represents a tremendous opportunity for operational success, and cumulative worker dose.

Efforts are still underway at SRNL to improve and mature Automation Technology for deployment in nuclear material handling environments.

REFERENCES

1. SRNL, SRNL-STI-2020-00049, REV 0 “Automated Handling and Unloading of 9975 Packaging,” 2020.