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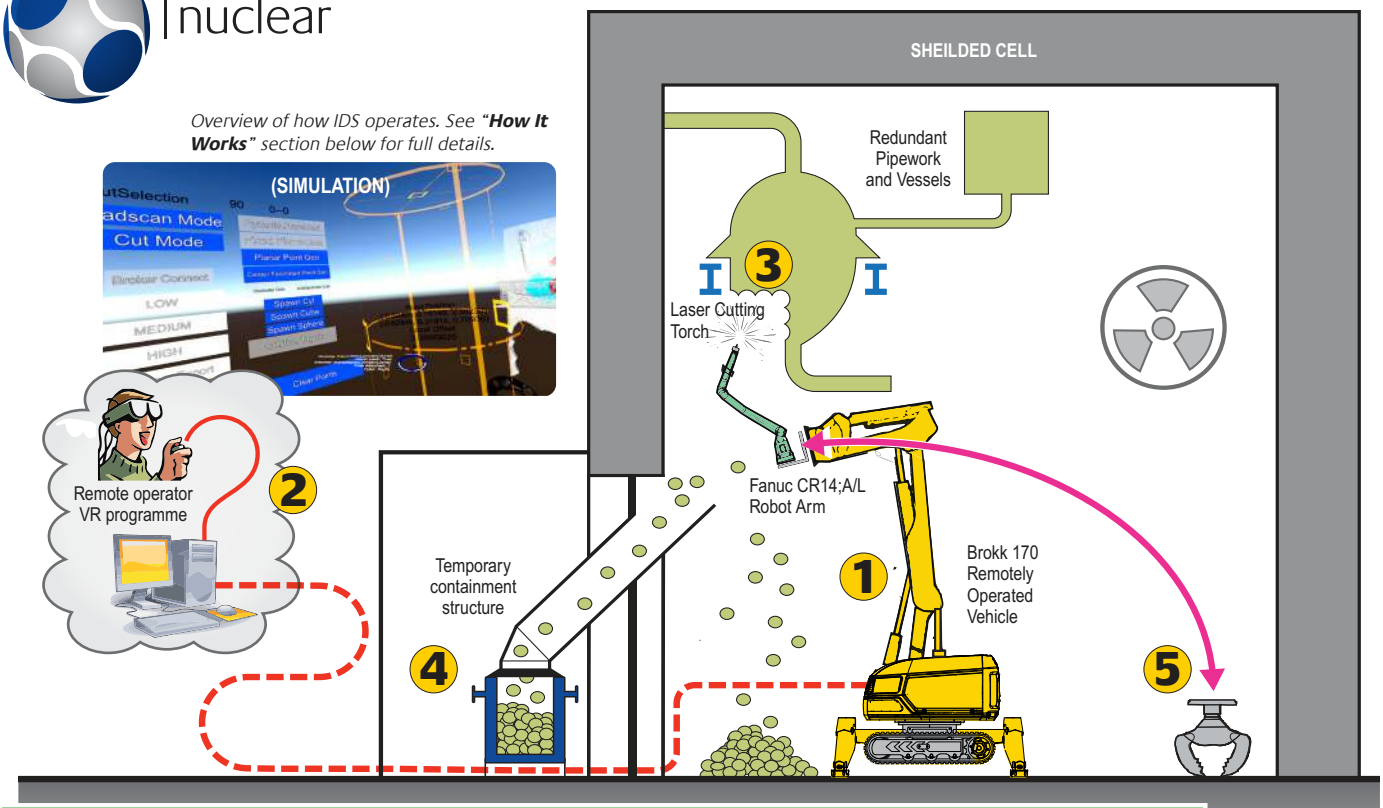
*Overview of how IDS operates. See "**How It Works**" section below for full details.*



PRODUCTS AND SERVICES:

In-Cell Decommissioning System (IDS)

OVERVIEW

The safe decommissioning of redundant nuclear reprocessing cells containing contaminated items can be a technically challenging and time-consuming task. Cavendish Nuclear and its partners have developed a system which combines technologies in spatial and radiometric scanning, remote deployment and virtual reality (VR) control to create a complete toolkit for safe and efficient decommissioning of these cells. It can:

- **Map and characterise the cell using 3D LIDAR scan and gamma spectrometry to create an accurate virtual environment**
- **Conduct automated size reduction decommissioning operations via remote VR control**
- **Conduct safe and efficient waste retrieval and packing operations via remote control.**

FEATURES AND BENEFITS

- Fully remote decommissioning solution
- Less people and equipment required
- Reduced man-machine interface
- Improved understanding of a continually changing operating environment
- Quick and easy programming of multiple cutting tasks via a VR operator interface
- Low risk pre-job planning, checking and refinement via VR interface using animated simulations
- Automated operations to ensure accuracy, repeatability and waste form consistency
- Progressive hazard reduction methodology
- Improved waste tracking and packing

HOW IT WORKS

1. The remote deployment device is used to conduct 3D surface image and radiological scans. 3D models then create a VR environment where radiological imaging is overlaid onto surface images.
2. The VR user interface enables the operator to program, check and refine automated cutting operations inside the virtual cell environment.
3. Once satisfied with the result, the operator downloads data to the deployment system and tools which subsequently size reduce process plant pipework and vessels into small coupons.
4. The waste is bulk collected and placed into
5. containers using a Brokk ROV with a clamshell bucket attachment, or individually retrieved using a grab.

OUR SOLUTION IN DETAIL

The IDS VR user interface was developed with an independent software broker, which can be configured to control a variety of tools and deployment devices. This enables customisation of the system to change its function and capability. It makes the system scalable and transferable; capable of addressing each unique decommissioning challenge. Two examples of customised IDS deployment systems are as follows:

Phase 2 Inactive Demonstration using OC Robotics' Snake Arm

Cavendish Nuclear and Babcock, partnered with OC Robotics (OCR) during previous project phases. OCR supplied a Snake Arm manipulator to deploy a range of tools. This technology was successfully demonstrated in 2018.

Phase 3 Sellafield STB Active Demonstration Proposal using Brokk ROV with Fanuc Robot

Cavendish Nuclear propose to use a Brokk 170 Remotely Operated Vehicle (ROV) with Fanuc CR-14iA/L robot arm attachment for deploying tools to decommission the Sellafield Solvent Treatment Bulge (STB). The ROV is able to remotely place down and pick up the robot arm and tools (e.g. scoops, a clamshell bucket). The robot arm is able to remotely change tools (e.g. LIDAR scanner, RadScan, laser cutting torch, grab, liquor removal device).

A proposed active demonstration involves removing all pipework and vessels from the STB cell.

IDS initially scans the cell to create a virtual environment. Thereafter the VR user interface is used to remotely programme automated cutting operations. Scanning is repeated regularly to update the continually changing cell environment. Waste collection is performed in between cutting operations using the ROV and various tools (e.g. a clamshell bucket, scoops, grabs). Waste coupons are deposited into a posting port chute to fill waste containers situated external to the cell.

Laser cutting is initially performed to remove low level pipework, vessels and obstructions, clearing a path for the deployment device. A liquor removal tool is deployed to sample and extract liquid waste from the mixer. The large vessel and some high level pipework is then size reduced to create space around the mixer and remaining pipework. On confirmation of liquor removal, the mixer and remaining pipework is decommissioned.

On removal of all vessels and pipework, laser cutting operations are performed to systematically remove material from the support steel and reduce the weight of the beams before eventually breaking span and completing decommissioning.

Summary

This innovation has potential to transform the way in which reprocessing cells and other redundant nuclear facilities are decommissioned on different nuclear sites. Its modular form enables it be customised to work with a range of deployment devices and tools, to effectively address each unique decommissioning challenge.

The results of inactive trials have exceeded expectations and the demonstrations have generated a considerable amount of interest from a number of clients in the UK and abroad.

Phase 2 Laser Cell with pipework and vessel mock-up.

Scanned Image of Phase 2 Demonstration Cell with radiological overlay.

Phase 2 Inactive Demonstration laser cutting operations.

A MODULAR SYSTEM WITH SCALABLE AND TRANSFERABLE DEPLOYMENT OPTIONS

Proven Technologies

- Individual technology elements have already been proven in the nuclear industry

Optimised Waste

- Flexible release by waste category
- Coupons – high packing fraction
- Just in time waste route delivery

End-to-End Remote Ops

- Fully remote solution
- Reduced man-machine-material interface

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