# DEVELOPMENT TESTING OF A NUCLEAR WASTE CASK REMOTE HANDLING SYSTEM

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## ABSTRACT

Radioactive waste shipping and receiving facilities presently planned for commercial and defense nuclear waste will handle waste packages at frequencies far in excess of those in common practice today. High radiation exposures and large personnel staffs would be necessary if current handling methods were used. To reduce personnel exposures and man-power requirements, alternate handling methods are being developed and demonstrated. Proof-of-principle testing of remote handling techniques using robotics demonstrated nearly all critical operations for cask receipt, preparation and unloading.

## INTRODUCTION

Cask handling technology development is being conducted by the Hanford Engineering Development Laboratory in Richland, Washington as part of the base technology activities of the Department of Energy's (DOE) Transportation Technology Center (TTC). A key aspect of this work is to establish required features on future generations of casks and to demonstrate the applicability of advanced handling techniques (Fig. 1) on similar cask designs. From the production nature of cask receiving operations, it was determined that commercial robotics might be incorporated in a remote handling system and used to reduce worker exposure while maintaining or increasing throughput. The radiation level in the cask handling area, while too high for full-time personnel occupancy, is low enough to permit entry for short periods. This means that maintenance operations on remote handling equipment can be performed using conventional techniques while the equipment remains in place, thus eliminating the need for remote maintenance.

Fig. 1. Telerobotic Workstation with Cask Mockup in Support Fixture.

## PROOF-OF-PRINCIPLE TEST

The first phase of remote handling system development culminated in a proof of principle test demonstrating the feasibility of remote cask handling using specially designed fixtures and tools. This remotely operated handling test demonstrated removal of a full scale Defense High Level Waste (DHLW) cask mockup from a shipping skid (Fig. 2), placing it into a vertical support fixture that simulates a facility cask cart (Fig. 1). The cask mockup was then prepared for unloading, using a commercial robot under both master-slave and automatic, preprogrammed control (Fig. 1). The captive bolts on the cask lid were loosened after removal of the dust cover and a simulation of the gas sampling operation. An electro-mechanical grapple was used to remove the closure and waste canister, and then to reinstall them, simulating a loading operation. Finally, the robot was used to retorque the bolts, reversing the initial operations.

The primary tool in demonstrating proof-of-principle was a pedestal mounted commercial robot modified for man-in-the-loop control with a joy stick controller (Fig. 3). The robot performs the cask preparation steps leading to the actual unloading operation. The preparation steps include dust cover removal, cavity gas sampling, and removal of the spring loaded captive closure bolts. These operations are performed with the robot in a preprogrammed mode which includes changeout of the various tools (end effectors) (Fig. 4).

An overhead robot (track mounted) will be used in a later prototype cask handling system to perform operations in the cask receiving areas. Fig. 5 shows a possible layout of equipment in a high volume cask shipping or receiving facility. Development testing showed feasibility of performing all the cask receipt, preparation and unloading operations from a single control station using remote controls and viewing. Systems or equipment necessary to accomplish this in a high volume waste shipping/receiving facility include the following:

- Overhead crane with digital position readout and positioning controls
- Rotating crane hook with position indicator
- Track mounted overhead robot with controls
- Pedestal or floor mounted robot with controls
- Intrafacility cask transfer cart
- Integrated control station
- Cask lifting yoke
- Remotely operated grapple
- Robot end effectors (tools)
- Radiation detection and analysis system
- Cavity gas sampling and analysis system
- Seal leak testing system

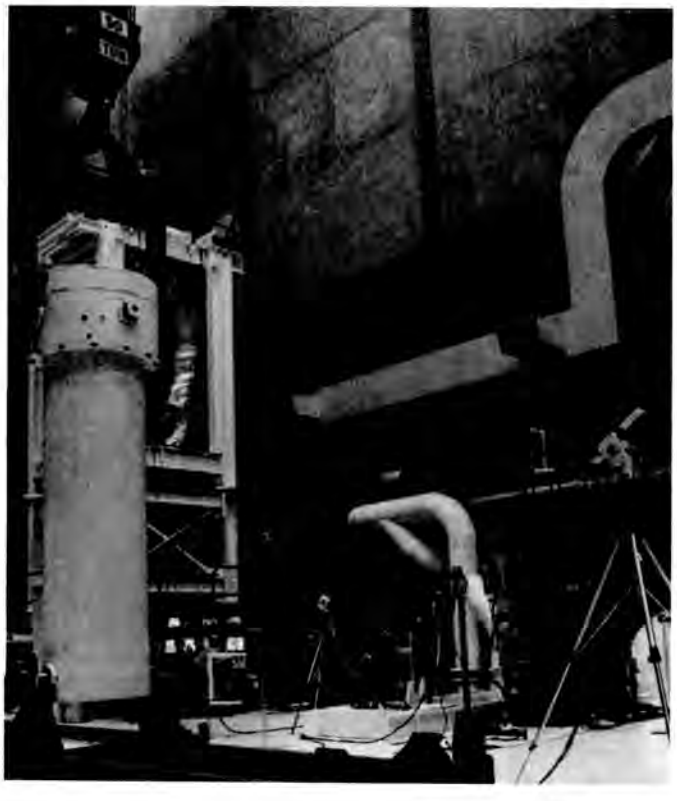

Fig. 2. Uprighting DHLW Cask Mockup on Shipping Skid.

Fig. 3. Cask Handling Workcell Control Station.

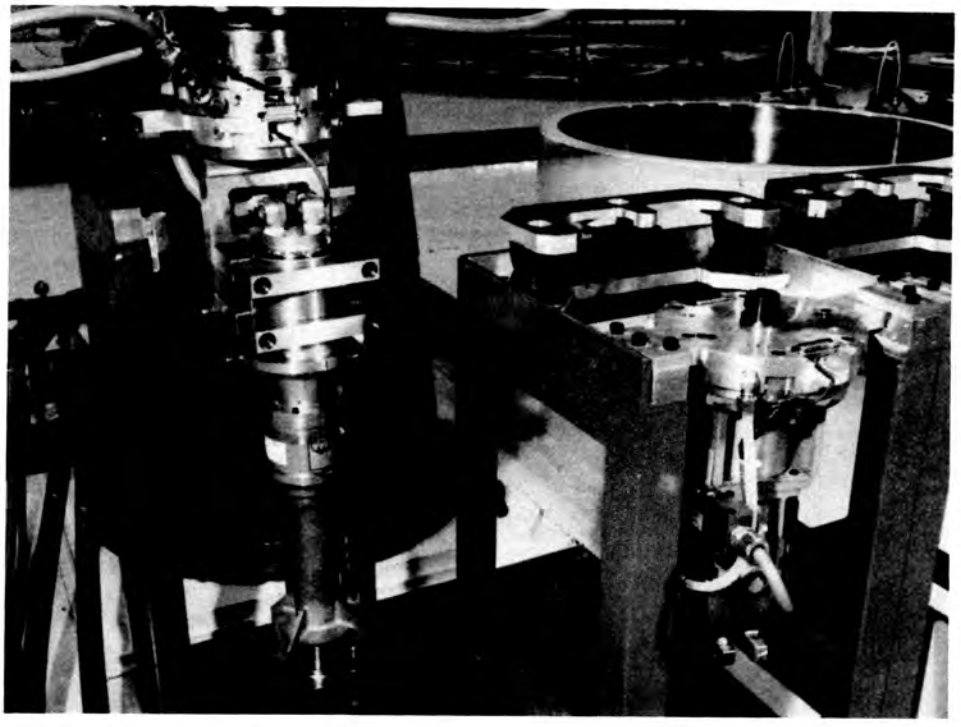

Fig. 4. Robot End Effector Quick Change System.

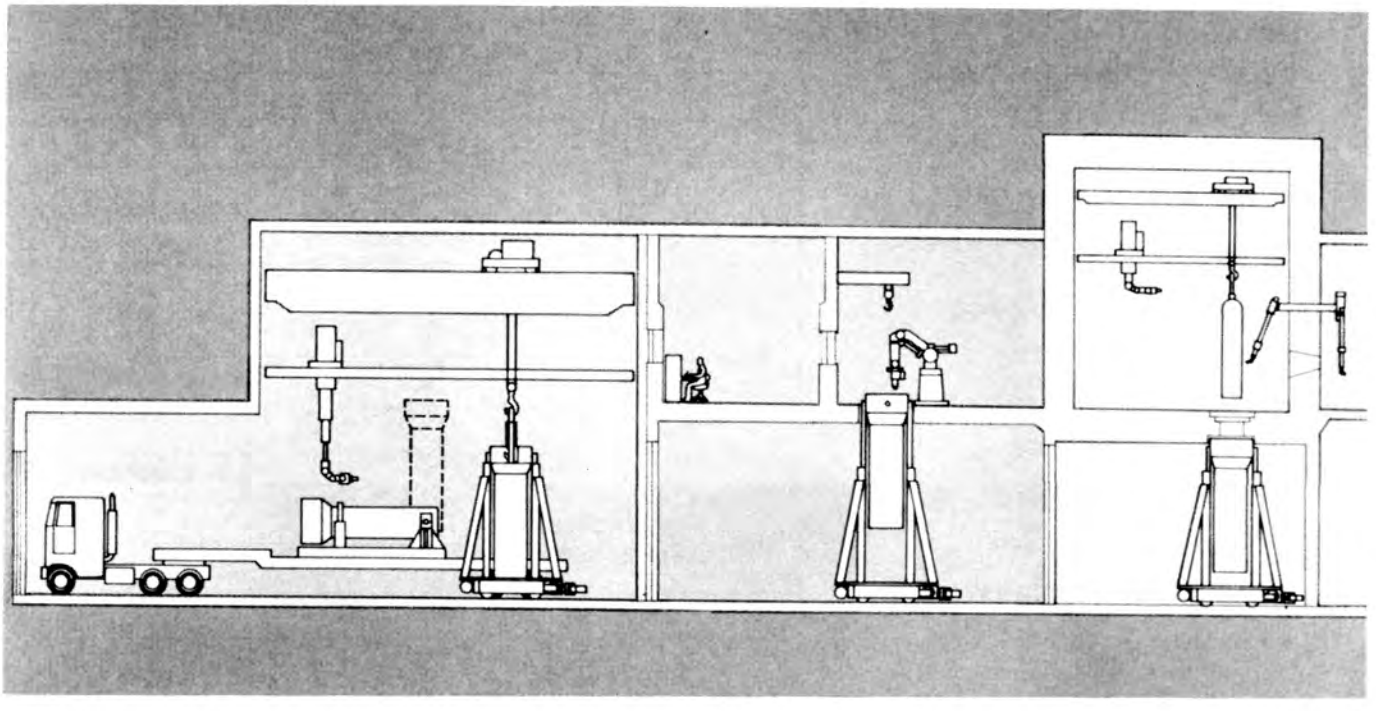

Fig. 5. Conceptual Layout of a Cask Handling Facility.

The benefits derived from use of robotics in the cask handling system include:

. Improved Handling Times

Measured times during demonstration of the handling system concept suggest as much as 50% reduction in turnaround times at cask shipping or receiving facilities (Fig. 6).

. Reduction of Personnel Exposure to Ionizing Radiation

A fully remote system would reduce personnel exposure to near zero for normal operation and provide the flexibility to deal with off-normal events. Laboratory feature testing demonstrated that all critical operations involving the waste cask can be handled remotely.

. Flexibility of Operations

Operational flexibility comes through software, man-in-the-loop control of the robot and the ability to quickly changeout robot tools (end effectors). This flexibility, demonstrated during the feature tests, makes possible any number of cask designs and sizes without need for new handling equipment.

## SUMMARY/CONCLUSIONS

A combination of conventional remote systems when coupled with robotics offers a solution to personnel exposure and facility throughput concern for future high capacity waste shipping and receiving facilities.

Proof-of-principle was demonstrated in recent tests utilizing a full scale mockup of the defense high level waste cask.

Development of the remote cask handling system will continue with definition, procurement and testing of a prototype system. The system design will be available about FY 1989 for use by designers of high throughput waste handling facilities.

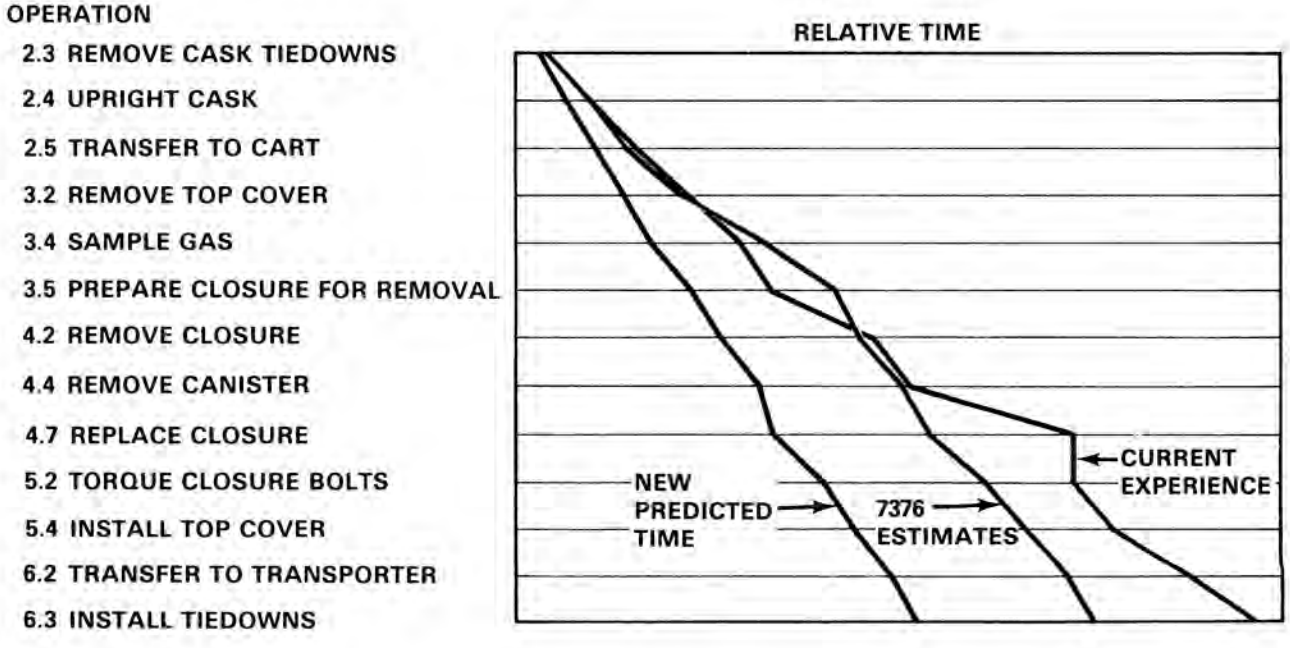


Fig. 6. Relative Comparison of Handling Times.