DEVELOPMENT AND USE OF A REMOTE WASTE HANDLING SYSTEM

FOR DISPOSAL OF GREATER CONFINEMENT WASTES

Richard Eric Williams
Reynolds Electrical & Engineering Co., Inc.
Post Office Box 14400, Las Vegas, Nevada 89114

ABSTRACT

This paper discusses the design and development of a remotely controlled waste handling system (RWHS) for use in radioactive waste disposal operations. A RWHS was developed at the U.S. Department of Energy's (DOE) Nevada Test Site for use in the Greater Confinement Disposal Test (GCDT). The RWHS consists of a remote control console and the following remotely operated features: a crane, a grapple/manipulator module which is suspended by the crane hoist hook, and closed-circuit television cameras. The RWHS was used to safely place high-specific-activity radioactive waste in greater confinement disposal. Between December 15, 1983, and February 23, 1984, five encapsulated sources were "open-air" transferred from shielded shipping casks and placed 30 m down a 3-m-diameter augered shaft using the RWHS. These sources contained approximately 460 kCi of Sr-90, 21 kCi of Cs-137, and 390 Ci of Co-60. Each source was transferred safely and efficiently and operational personnel did not receive any recordable doses.

## RWHS DEVELOPMENT AND DESIGN

In 1981 the National Low-Level Waste Management Program and the DOE Nevada Operations Office began the GCDT project to demonstrate improved disposal methods for high-specific-activity and environmentally mobile radioactive wastes. The GCDT uses a 3-m-diameter, 36-m-deep augered shaft for radioactive waste disposal in alluvial sediments at the Nevada Test Site.[1,2] Because of high radiation levels, the transfer of radioactive wastes from shipping casks to the shaft required the development of a multipurpose RWHS.

In developing the RWHS for the GCDT the following design features were considered necessary:

- all-weather construction for use in field operations,
- full remote operation up to a distance of 150 m,
- ability to handle a variety of waste sources and packages,
- ability to handle 2.27-Mg loads for placement at depths up to 36 m,
- ability to visually monitor above and below ground operations through a remote-controlled video system, and
- usable in other routine waste management operations.

Based on these *criteria*, Pacific Nuclear Systems & Services, Inc., designed and built the RWHS for the GCDT project.[3] The RWHS design consists of three parts. The first is an 18-ton, all-terrain crane that has been modified to allow remote control of the boom and reeling functions (Fig. 1). During remote operations, the crane body is kept stationary. The boom controls (i.e., telescope, swing, hoist, and angle) are electro-mechanical and give the operator inching capability. To facilitate placing sources downhole, the boom angle and swing controls can be set so that remote indicators light up when the end of the boom is centered over the GCDT shaft. A camera, located behind the crane cab, monitors a set of crane function indicators, which include fuel level, oil pressure, engine temperature, and boom angle. The crane can be operated manually for routine operations.

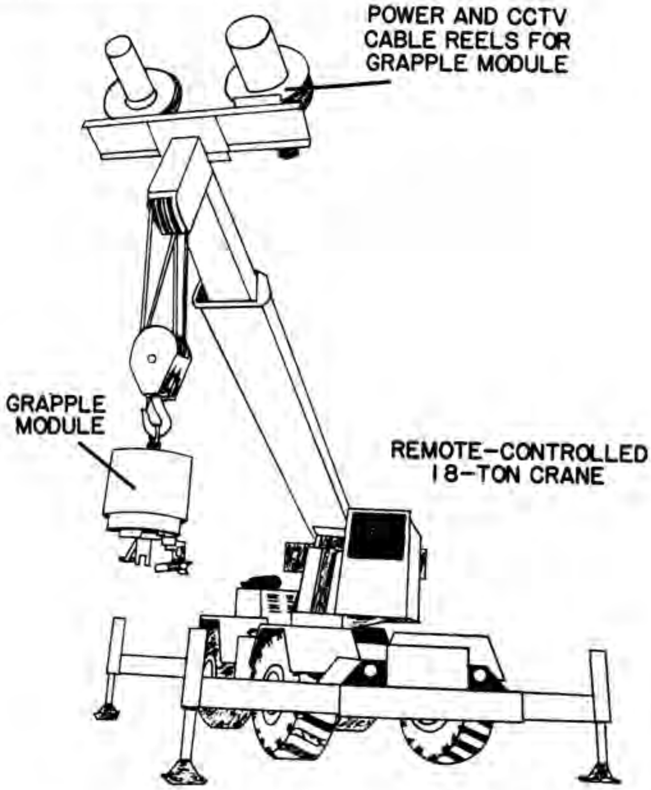


Fig. 1. GCDT remote waste handling system.

This work was supported by the DOE Nevada Operations Office under contract DE-AC08-84NV10327.

The second part of the RWHS is the remote-controlled grapple module (Fig. 2). It is suspended by the crane hoist hook and includes the following features:

- load cell transducer with remote readout,
- remote 360° rotational capability,
- positive-pressure (fail-closed) locking pin and clevis grapple,
- remotely positionable video camera and lights,
- modular design for adaptability to other lifting systems,
- structural design with a 7:1 safety factor,
- remote readout of grapple depth, and
- various manipulator tool attachments.

Automatic cable uptake reels for the camera, lighting, and power cables are mounted on the crane boom. In addition to the grapple camera, an aboveground surveillance camera that can be positioned for remote viewing of the entire waste handling operation is included. Both cameras have pan, tilt, and zoom capabilities. When used in tandem, the cameras provide the operators with some degree of depth perception.

The camera on the grapple module allows close-up viewing of source pickup operations. This permits the crane operator to properly and efficiently position the grapple module while using the remote controls. This camera also allows viewing of downhole operations. With this capability, the waste can be positioned in the disposal shaft to attain higher loading efficiencies than would otherwise be possible.

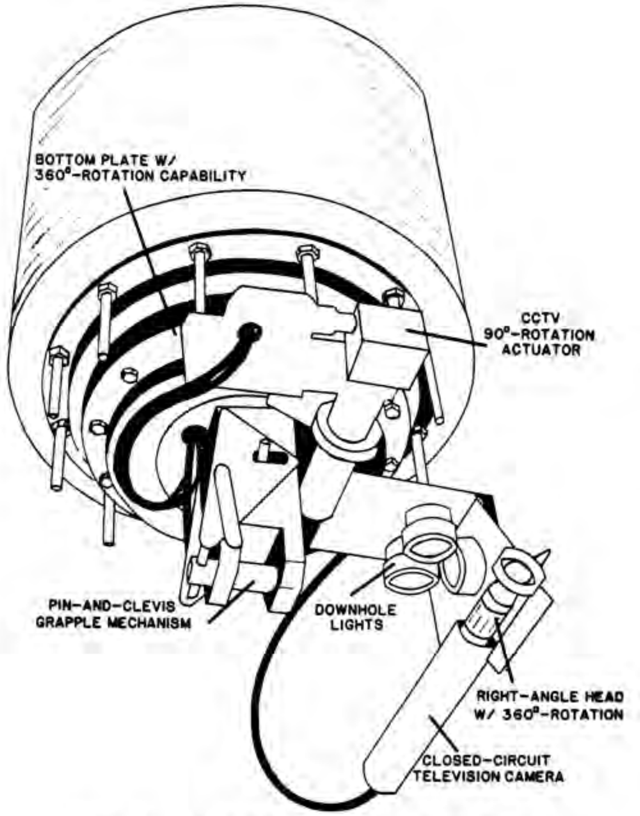


Fig. 2. RWHS grapple/manipulator module.

The third part of the RWHS is the remote console for controlling the operation of the crane, grapple module, and video components (Fig. 3). The console can be located up to 150 m from the crane location. The console's remote control features include:

- three high-resolution, black and white video monitors,
- grapple module camera and lighting controls,
- surveillance camera controls,
- grapple actuator control,
- grapple load weight and depth indicators,
- grapple open/closed indicator, and
- crane boom controls.

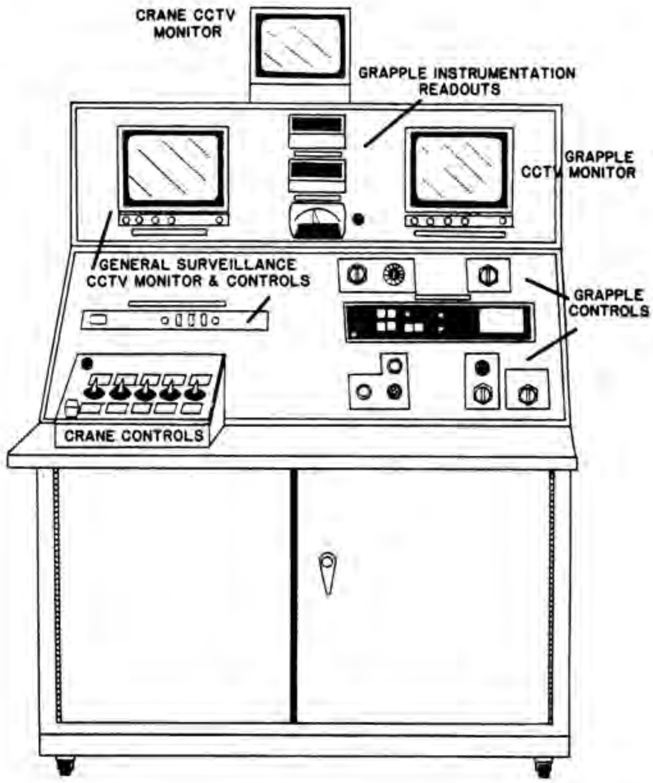


Fig. 3. RWHS remote control console.

## REMOTE EMPLACEMENT OF GCDT WASTES

### Preparation and Training

To ensure safe and efficient disposal of high-specific-activity sources, remote transfer operations were rehearsed using mock-ups of the different sources and casks. All remote transfers utilized two operators: one to handle the crane controls and one to operate the grapple and camera controls.

The control console was located at least 100 m from the crane to reduce operator exposures during source transfer operations. An earth berm was constructed between the console and the crane to further reduce the direct radiation received at the console. Radiation survey meters and thermoluminescent dosimeters were used to determine the radiation levels and integrated doses at various distances for each transfer operation.

## Source Transfers

On December 15, 1983, four capsules containing a total of 345 kCi of Sr-90 were placed in the GCDT shaft. The capsules were transferred in a specially fabricated basket from a GE-1500 shipping cask (Fig. 4). A bolt, welded to the top of the basket, provided a positive locking point for the grapple module's three-fingered manipulator tool and guaranteed the containment of the four capsules. The transfer of this Sr-90 source basket from the cask to 30 m down the GCDT shaft was completed in approximately ten minutes. The peak exposure rates for this operation were over 1700 R/h at 1 m and approximately 35 R/h at 10 m and 50 mR/h at the control console (100 m away). However, due to the brevity of the exposure, no recordable doses were incurred by personnel.

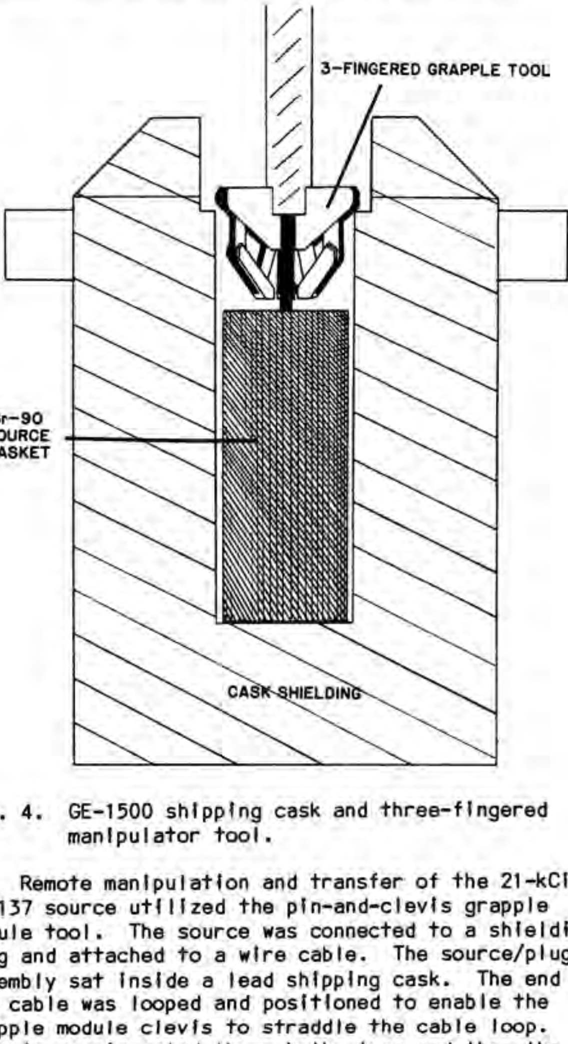


Fig. 4. GE-1500 shipping cask and three-fingered manipulator tool.

Remote manipulation and transfer of the 21-kCi Cs-137 source utilized the pin-and-clevis grapple module tool. The source was connected to a shielding plug and attached to a wire cable. The source/plug assembly sat inside a lead shipping cask. The end of the cable was looped and positioned to enable the grapple module clevis to straddle the cable loop. The pin was inserted through the loop and then the source/plug assembly was lifted from the cask and lowered down the GCDT shaft. The transfer of the Cs-137 source required five minutes. Peak exposure rates exceeded 2300 R/h at 1 m and were approximately 60 R/h at 10 m and 40 mR/h at the console (now at 120 m). Again personnel did not receive any recordable doses.

Next, two encapsulated Co-60 sources were remotely transferred to the GCDT shaft. The first, a 290-Ci source, was stored in a Lawrence Livermore National Laboratory neutron shipping cask and gamma shield, Model 4-T (Fig. 5). A unique retrieval tool, held by the grapple module's three-fingered tool, was used to mechanically thread a screw hole on top of the special-form capsule. The retrieval tool was a modified Yankee automatic screw driver contained in a cylindrical, self-centering, lucite shield and provided the crane operator with enough dexterity to thread the 60-mm screw hole.

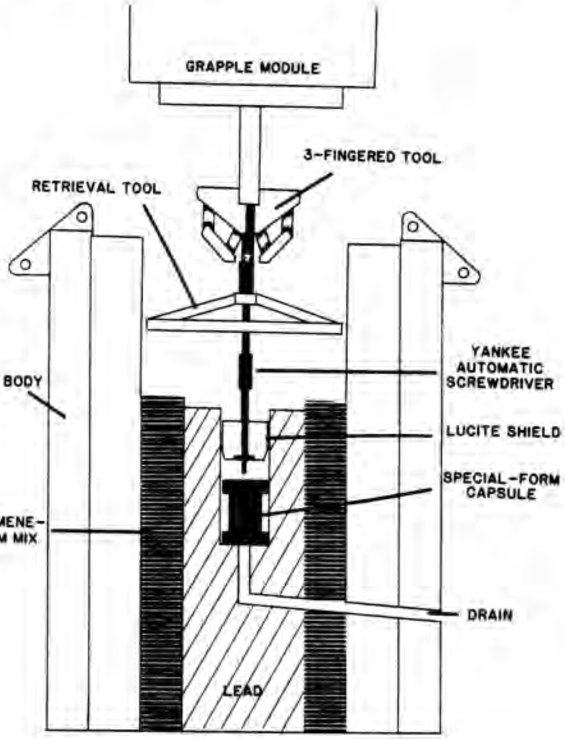


Fig. 5. LLNL Model 4-T shipping cask and specially designed retrieval tool.

The second source, containing 100 Ci of Co-60 sat in a lidless 4-L paint can inside a lead shipping cask. The finger tips of the three-fingered tool were modified so that in the "full-open" position, flanges would protrude under the lip of the can. As with the previous source transfer operations, no recordable doses were received by personnel at the control console location as a result of the disposal.

The last fully remote source transfer was conducted on February 23, 1984. This source, a SNAP-23A radioactive thermoelectric generator, contained a 116-kCi Sr-90 heat source encased in an U-8Mo biological radiation shield. The shielding reduced the potential dose rate at 1 m to about 10 mrem/h. The three-fingered tool was used to transfer the source/shield assembly to the GCDT shaft. No recordable personnel doses were received.

After this last source was placed at the 30 m depth in the GCDT shaft, the exposure rate at the surface was 6.5 R/h directly over the shaft. Approximately 14 cu. m of sifted alluvium were then placed over and around the sources. This covered the sources with about 1 m of backfill and reduced the surface radiation levels to below 30 mR/h.

## SUMMARY

The five sources disposed of using the RWHS were transferred without incident and without the operators or other personnel receiving any measurable dose. The RWHS modular design demonstrated the system's ability to be adaptable to changing operational requirements. The different source manipulating tools were accessible to the grapple module operator during each source handling operation. The ability to use the RWHS to safely "open-air" transfer sources with high radiation levels allowed the expensive shipping casks to be retained for future use. The success of these GCDT operations provides a high degree of confidence to meet future demands in radioactive waste handling requirements.

## REFERENCES


1. Dickman, P. T., and J. R. Boland, "Greater Confinement Disposal Test at the Nevada Test Site," Proc. Symposium on Waste Management, Tucson, Arizona, February 27-March 3, 1983, Vol. 1, p. 519-521.

2. Dickman, P. T., and J. R. Boland, "Greater Confinement Disposal Test Operating Experiences," Proc. 6th Annual Participants' Information Meeting, DOE Low-Level Waste Management Program, Denver, Colorado, September 11-13, 1984, p. 269-275, CONF-8409115.

3. Schmoker, D. S., "Remote System for Burial of High-Specific-Activity Low-Level Radioactive Waste," Trans. American Nuclear Society Annual Meeting, New Orleans, Louisiana, June 1984.