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SHIELDED CAVES FOR DUAL-MODE OPERATION

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SHIELDED CAVES FOR DUAL-MODE OPERATION*

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ABSTRACT

A family of one-foot-thick water shielded facilities has been constructed to permit rapid, convenient manipulations on intensely alpha active materials. Although nominally a manipulator operated containment enclosure, each shield contains the feature of allowing gloved operations in the enclosure on demand with minimal expenditure of time or effort. The basic shield encloses a replaceable alpha confinement box and provides shielding on four faces of the box, the top and rear not being shielded. Rear shielding is provided by locating the units against a structural concrete wall or heavy cell wall.

INTRODUCTION

Several lightly shielded facilities of similar design have been constructed at Lawrence Livermore Laboratory to handle intensely alpha active materials. These caves consist of a 11-inch thick water shield surrounding a replaceable alpha confinement box; remote manipulations in the enclosure are performed with Model 7 master-slave manipulators. For set-up operations, the operator has the option of moving the front shielding tank to the open position to work in the box with either gloves or manipulators. The portable model of these "water caves" has a counter-weighted front window tank that pivots under the shielding (Fig. 1).

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

The fixed version is built as a full height window tank that rolls on a laterally offset position in a rail cast into the floor (Fig. 1). In both versions, the alpha box is shielded by 12-inches of water contained in 4-in.-dia. thick steel tanks. The top edge of the box is left unshielded for manipulator access, and rear face shielding is provided by latching the facility against an existing shield or structural concrete wall.

CONSTRUCTION DETAILS

The unusual feature of these facilities is the capability of utilizing glove operation in the alpha box with minimal expenditure of time or effort without disabling the Model V manipulator. Four 4-inch-diameter glove ports have been inserted in the lower section of the confinement box window below the normal line of vision Fig. 3. Access to these glove ports is readily available by opening the front shielding tank (or door).

In the portable cave this is done by pivoting the entire front shielding tank, which contains the viewing window under the structural shield (Fig. 1). This tank is connected by two roller chains to a lead counterweight behind the main shield. An electric-motor-powered gear-reducer provides the motive force to lift the tank to the shielded operating position. A common drive shaft connected to both chains with captured sprockets prevents twisting or warpage of the tank when it is in motion. When in the raised position, two lever locks secure the window tank to the main shielding tank which forms the bottom and two sides of the structure.

The fixed version of this cave system (Fig. 2) has two side tanks which are secured to the floor and to a heavy cell wall. The front window tank which is supported by wheels rolling on a rail cast into the floor, can be offset laterally. A unique three-point support system holds the door tank in a vertical position and eliminates interference from overhanging structures. In the open position, the rolling door is restrained in the upward direction by keepers at lower ends of the door tank. These keepers have fingers which are shaped to extend under the ledge

of the wall. Guides at the top of the door slide in a U-shaped track and restrain the door in two horizontal directions. Stops at the top of the door restrict the door from moving too far in the open position. The structure of the window tank has been reinforced for potential earthquake forces acting on the tank, which in turn react through the three load points.

One advantage of this door drive system is that the manipulators are operational in any door position, and that the door need not be fully opened to obtain access to one of the side glove ports.

VIEWS WINDOW

In both versions the front shielding tanks contain full-width water-filled windows for an unobstructed view of the inner alpha enclosure. The window compartment is constructed from bead-blasted type 304 stainless steel and the transparent plates are made from 1-1/2-inch-thick clear acrylic plastic. Square gasket grooves are milled into the outer surface of the plates and the plates are installed from the inside of window compartment. In this way, the head pressure assists in making the cover plate seal.

A closed loop water purification system (Fig. 4) has been provided to maintain optically clear water in the viewing compartment. This system includes a "funnel" stainless steel pump and a 200-micron frit for removal of large particles. Dissolved impurities are removed from solution by a hydroxyl form anion bed and a hydrogen form cation bed. Half-inch O.D. stainless tubing is used to interconnect the components except in the bypass loop where the size has been reduced to 1/4-inch O.D. A vented reservoir is included in the bypass loop to compensate for thermal expansion, and also serves to remove air bubbles from the system. Both liquid lines extend to the bottom of the reservoir so that a siphon can not be started even though the reservoir is located below the normal liquid level in the viewing compartment.

CONFINEMENT BOX

The floor dimension of the alpha enclosure are 76-inches wide by 41-inches deep. All of the floor area can be serviced by at least one master-slave, and 1/3 of the floor area can be serviced by both slaves. The four 6-inch diameter glove ports permit manual manipulations in the front 1/3 of the box. Equipment can be transferred to or from the box via a 9 by 10-inch remotely-operated box door which mates with an external stepped-shielding-plug in the water tank. Manipulator boots can be replaced with the same technique used for replacing gloves. The normal ventilation rate is 60-90 CFM, and the static pressure in the alpha enclosure is maintained at 0.1 inch water column negative pressure by the inlet air filter incorporated in the box.

CONCLUSION

These shielded caves have fulfilled the requirement for an alpha handling facility which retains the convenience of gloved operation, yet has a remote handling capability. The transition from slaves to gloves and back to slaves can easily be made in only a few minutes. As the containment boxes are easily removable from the shield and are interchangeable between different shields, these facilities provide great flexibility in operation. A complete interchange of equipment can be performed in one day and the used box and equipment can be saved for reuse without disassembling any internal hardware.

As most of the alpha decay of actinides emits only soft gamma rays from alpha decay, the 1 inch thickness of water allows the handling at normally allowable working tolerances of hundreds of grams of americium or plutonium isotopes, or gram quantities of curium isotopes. The water barrier also acts as a neutron shield and provides adequate shielding for handling up to 200 microgram quantities of ^{252}Cf or the equivalent fast neutron flux of other spontaneously fissioning isotopes ($\sim 4 \times 10^5$ n/sec).

REFERENCE

1. M. S. Coops and C. I. Hansen, "The Livermore Neutron-Shielded Chemistry Cells (I) Configuration and Philosophy", Proc. 1967 Conf. Remote Syst. Tech. (1967).

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FIGURE CAPTIONS

Fig. 1 Portable Cave, Door Open.

Fig. 2 Fixed Position Cave, Door Open.

Fig. 3 Normal Operating Configuration, Portable Cave.

Fig. 4 Water Window Purification Loop.

Fig. 1

Fig. 2

Fig. 3

Fig. 4