INTERIM STORAGE OF RH-TRU 72B CANISTERS AT THE DOE OAK RIDGE RESERVATION[1]

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ABSTRACT

This paper describes an evaluation performed by the Department of Energy (DOE) Oak Ridge Operations (ORO) office for potential interim storage of remote-handled (RH) transuranic (TRU) 72B waste canisters at the Oak Ridge National Laboratory (ORNL). The evaluation included the conceptual design of a devoted canister storage facility and an assessment of the existing RH-TRU waste storage facilities for storage of canisters. The concept for the devoted facility used modular concrete silos located on an above-grade storage pad. The assessment of the existing facilities considered the potential methods, facility modifications, and conceptual equipment that might be used for storage of 400 millisievert per hour (mSv/hr) canisters. The results of the evaluation indicated that the initial investment into a devoted facility was relatively high as compared to the certainty that significant storage capacity was necessary prior to the Waste Isolation Pilot Plant (WIPP) accepting RH-TRU waste for disposal. As an alternative, the use of individual concrete overpacks provided an incremental method that could be used with the existing storage facilities and outside storage pads. For the concrete overpack concepts considered, the cylindrical design stored in a vertical orientation was determined to be the most effective.

INTRODUCTION

The DOE-ORO is planning to treat and repackage the RH-TRU waste currently in storage at the Oak Ridge Reservation (ORR) into canisters for shipment to the WIPP for disposal. The Waste Processing Facility (WPF) is being constructed to perform the treatment and repackaging of RH-TRU waste. The WPF is designed to receive and process TRU waste sludge currently in tank storage and containerized TRU waste solids from facility storage. The WPF will process the waste and achieve the maximum feasible volume reduction for the RH-TRU waste to be disposed at the WIPP. The tank sludge will be treated to stabilize the heavy metals and dried to meet the WIPP acceptance criteria regarding liquids. The RH-TRU waste debris will be evaluated and separated into three waste streams; RH-TRU waste, CH-TRU waste, and low-level waste (LLW). The RH-TRU and CH-TRU waste will be sent to the WIPP for disposal and the LLW will be shipped to the Nevada Test Site (NTS) for disposal.

The WPF packages RH-TRU waste into the WIPP-approved RH-TRU 72B canister. The canister is a steel cylindrical container that is 121 inches in length and 26 inches in diameter. The canister is designed to accommodate three 55-gallon drums and has an internal volume of 0.9 cubic meters. The canister is constructed of 0.25-inch thick mild steel and has a maximum gross weight (i.e., canister plus the contents) of 8,000 pounds.

The current baseline schedule calls for the WPF to start processing tank sludge in December of 2002 and the first canister to be ready for shipment to the WIPP in January of 2003. Thereafter, the WPF generates approximately twelve canisters per month that contain processed RH-TRU waste sludge. The processing of sludge is anticipated to continue until June of 2004. Starting in January of 2004, the WPF begins processing RH-TRU waste debris and generate canisters containing debris at the rate of approximately 2.5 canisters per month. The processing of debris is anticipated to continue until 2008.

The WIPP is not currently approved for receipt and disposal of RH-TRU waste. The WIPP is completing a proposed RH-TRU waste program that will be forwarded to the regulators in 2002 for approval. The approval and implementation of the WIPP RH-TRU waste program is not anticipated before the DOE-ORO plans to initiate packaging of RH-TRU waste into canisters. If packaging into canisters proceeds as scheduled, the DOE-ORO may need to provide interim onsite storage until WIPP is ready to receive the canisters for disposition. In preparation for that possibility, the DOE-ORO considered the conceptual design of a devoted 72B canister storage facility and various approaches for use of the existing RH-TRU waste storage facilities for interim canister storage. This report presents the results of the DOE-ORO evaluation.

CONCEPTUAL DESIGN OF A DEVOTED 72B CANISTER STORAGE FACILITY

The DOE-ORO considered the conceptual design of a devoted above-grade "modular" storage facility that could be expanded as necessary to meet the need for additional canister storage capacity. The proposed facility (Figure 1) consisted of a reinforced concrete pad, a remotely operated bridge crane that traversed the pad, and concrete slab silos that contained the canisters. The size of the facility was 230 feet long and 60 feet wide with a bridge crane that operated on rails approximately 30 feet above the pad. The hoist capacity was 10 tons and could fully traverse the 60-foot wide trolley. The trolley rolled along the top of a structural steel support framework erected around the perimeter of the pad. The crane was controlled by a radio remote controller located in a control building situated behind an earthen berm for shielding the operator. The control building contained three video monitors displaying the input from two fixed "X" and "Y" axis cameras for positioning the crane and one general usage camera.

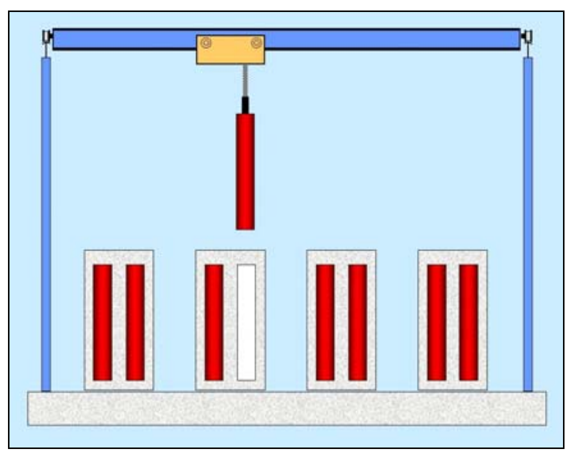

Fig. 1. Conceptual Design of a 72B Canister Storage Facility

The rectangular concrete silos were designed to be 11 feet high, 14 feet deep, and 7.5 feet wide. The silos were to be constructed by stacking eleven 1-foot thick reinforced concrete slabs that contain eight 28-inch diameter holes for the canisters. The silos had a weather cap to protect the canisters from weather exposure. The pad could hold a total of 44 silos and provide storage for 352 canisters.

The conceptual design was judged to be technically feasible but not programmatically desirable. The major drawback was the need to commit early for a large initial investment. While there would be some cost savings by adding the crane framework and silos as needed, the majority of the cost would be associated with the trolley, hoist, and control system which would be purchased and installed prior to startup. Since the DOE intends to open the WIPP for RH-TRU waste in the next few years, the DOE-ORO did not consider the high initial expense of the devoted silo design appropriate if viable short-term methods could be identified. As an alternative to constructing a devoted facility, the DOE-ORO considered the storage possibilities offered by the existing RH-TRU waste facilities.

72B CANISTER STORAGE USING EXISTING FACILITIES

The containerized RH-TRU waste at ORNL is currently stored in shielded facilities designed to store concrete storage casks. The current plan is for the RH-TRU waste facilities to be closed when the current inventory is removed for processing with the exception of Building 7883 which will remain open for the foreseeable future. Building 7883 is a rectangular bunker-type facility divided into four rectangular bays with internal dimensions of 18 feet wide by 56 feet deep by 14.5 feet high. The front of each bay has a rollup door for individual access. The floor is a 10-inch thick reinforced concrete slab designed to accommodate 4,000 pounds per square foot (lbs/ft^2) live loads. The outer walls are constructed of 14-inch thick concrete and the common walls between the bays are constructed of unfilled 12-inch thick concrete block. The sides, back, and top of the facility are covered with several feet of soil for radiation shielding. The distance from Building 7883 to the WPF is less than 0.5 miles on non-public access roads.

A primary concern related to managing the 72B canisters is the application of radiation shielding during the handling, transport, and storage to keep the radiation exposure As Low As Reasonably Achievable (ALARA). A typical canister with processed sludge or debris could have an external gamma exposure rate of 400 mSv/hr on contact. The canister is to be packaged in the WPF using remote-handling techniques and personnel shielding. Once a canister is packaged, a shielded transport mechanism is required for transfer of the canister from the WPF to the storage facility. Once in storage, shielding for the waste operations personnel working in the facility or area is required.

Storage of Canisters in Building 7883

Two general approaches are considered for storage of 72B canisters in Building 7883. The first approach (i.e., the "unshielded canister storage" approach) involves transferring the canisters to the storage facilities using an on-site transfer cask that provides shielding and additional containment. The transfer cask is positioned in the storage facility and the canister removed from the transfer cask using a remotely-operated mechanism. The canister is then placed into a storage location that provides adequate radiation shielding through a combination of facility shielding and administrative controls.

The second general storage approach (i.e., the "overpacked canister storage" approach) involves placing the canister into a shielded overpack, transferring the overpacked canister to the storage facility, and storing the overpacked canister in the storage facility.

There are several conceptual arrangements that could be used for storing unshielded and overpacked canisters. The evaluation is limited to one vertical and one horizontal storage arrangement for each case to demonstrate the level of engineering, risk, facility modifications, authorization documentation, and storage capacity associated with unshielded canister storage.

Vertical Unshielded Canister Storage

One method for transferring and storing canisters is represented in the left half of Figure 2. The canister (the red cylinder) is transferred to the storage location using a tunnel-type shield cask mounted on a trailer. The canister is attached by the pintle at the top of the canister to a structural steel deck that can be inclined from a horizontal to vertical position by a hydraulic ram attached to a weighted trolley. For transport, the canister is in the horizontal position and inside of the shield cask (transparent blue box) with the cask closure hatch in place.

For storing canisters, the following sequence is proposed:

- Move the trailer close to storage location,
- Evacuate personnel in the immediate area,
- Remove the closure hatch using a crane,
- Back the trailer into the precise location for canister placement,
- Lower the trailer stabilizers,
- Move the trolley out of the shield tunnel and position at the end of the trailer,
- Incline the canister from a horizontal position to a vertical position,
- Lower the canister using the hydraulic canister deck,
- Release the pintle,
- Raise the trailer stabilizers,
- Pull the trailer from the radiation area,

- Secure the back hatch, and
- Secure the trailer for the next use.

All of the trailer equipment is operated remotely and use of video cameras for placement of the canister is required.

One concept for storing unshielded canisters in a vertical position in Building 7883 is to use "L"-shaped concrete shield walls in a square matrix (bottom left in Figure 2). First, the canister is placed in the next available "cell" using the shielded transfer vehicle. Then, the shield walls are moved into position using a remotely-operated forklift. The shield walls effectively create open-ended, vertical boxes around the canisters. The shield walls are greater than 13 feet in height to reduce the skyshine and backscatter in the unshielded area. Placement of steel plates on top of the shield walls or additional soil cover can be used to reduce the radiation exposure levels on top of Building 7883. Using this approach with the proper controls, in excess of 60 canisters can be stored per bay.

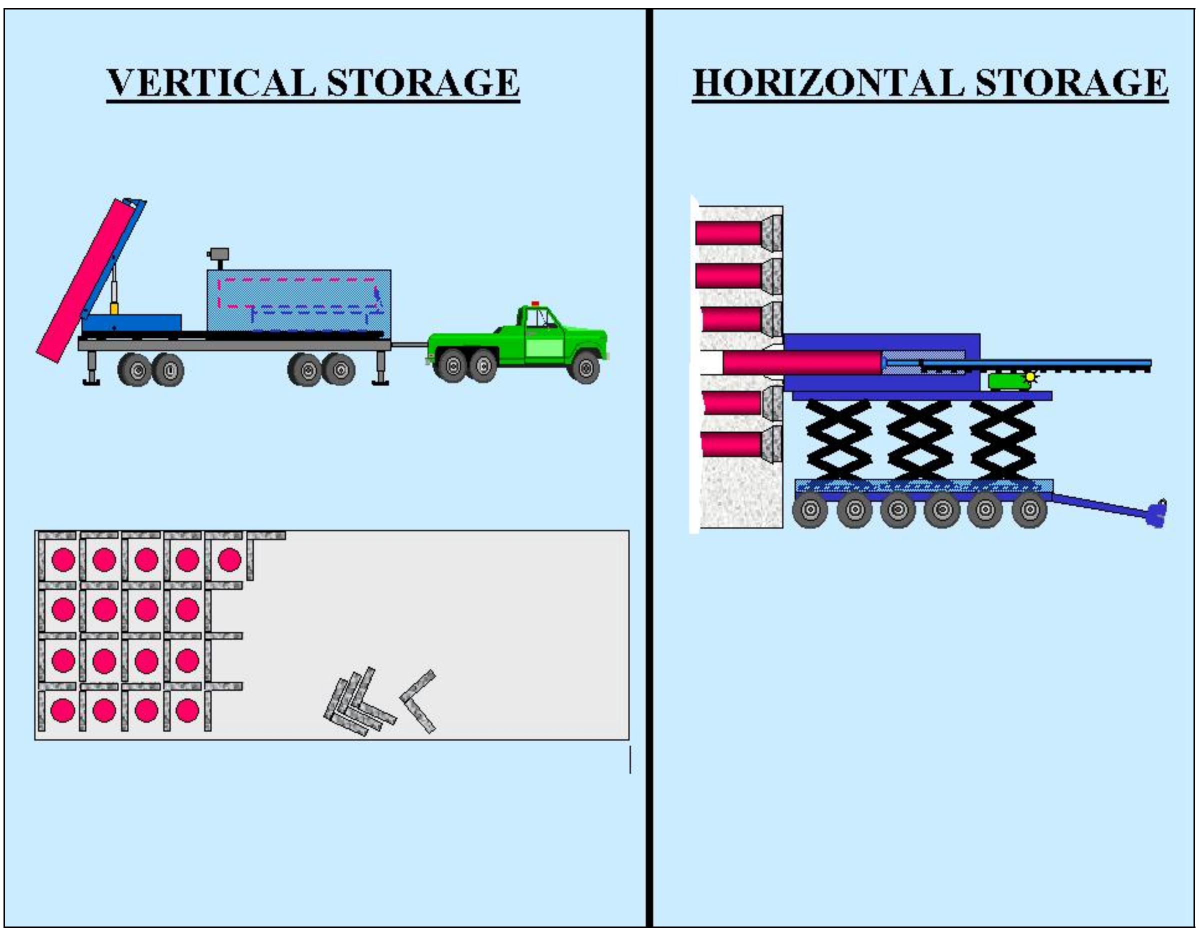

Fig. 2. Conceptual Unshielded Storage Methods for 72B Canisters

Horizontal Unshielded Canister Storage

One concept to transfer and store canisters in a horizontal storage position is illustrated in the right side of Figure 2. The canisters are stored in a concrete shielding structure that has 29-inch diameter horizontal pipe inserts. The inner surface of the insert incorporates guide strips of Teflon™ or Tefzel™ to allow the canister to slide freely. The concrete shield structure is constructed of pre-cast sections, concrete block, or concrete pipe (i.e., "sewer pipe") in racks. The shield dimensions are approximately 13 feet deep, 10 feet high, and 12 feet across and each bay can hold three shields.

The canisters are placed in the shielding structure using a horizontal transfer unit. Each canister is attached by the pintle (or electromagnet) to a plunger that moves along the length of a shielded transfer unit. For transport, a canister is fully inside of the transfer unit, the positioning deck fully lowered, the end hatch in place, and the plunger extension removed. The transfer unit is attached directly to a vehicle, or transported on a lowboy flat bed trailer and off-loaded at the storage site.

For storing canisters, the following sequence is used:

- Move the transfer unit close to storage location,
- Remove the shield plug for the intended storage location using a crane or forklift,
- Evacuate personnel in the immediate area,
- Remove the transfer unit hatch using a crane or forklift,
- Back the transfer unit under the storage location,
- Raise the positioning deck to the required level,
- Back the transfer unit firmly against storage structure,
- Block and lock the transfer unit wheels,
- Attach the plunger extension,
- Engage the plunger and push the canister into the insert,
- Disengage the canister and fully retract the plunger,
- Unblock and unlock the transfer unit wheels,
- Move the transfer unit several inches from the storage structure,
- Lower the positioning deck fully,
- Remove the transfer unit from the storage area,
- Replace the shield plug using a crane or forklift, and
- Secure the transfer unit for the next use.

In excess of 70 canisters can be stored per bay in Building 7883 using the pre-cast, high density concrete.

Vertical Overpacked Canister Storage

The concept considered for vertical storage of overpacked canisters is the use of cylindrical shield containers. Three conceptual designs for cylindrical canister overpacks are considered in the evaluation (top left illustration in Figure 3). The first design is an all-steel overpack (steel is represented in blue). The second design is a combination of normal-density concrete and steel. The third design is reinforced high-density concrete. Table I summarizes the characteristics of each design.

Table I. Overpack Characteristics

OVERPACK PROPERTY	STEEL OVERPACK	COMBINATION OVERPACK	CONCRETE OVERPACK
Overall height[a]	11' 4"	11' 8"	12' 6"
Diameter[b]	3' 0"	3' 9"	3' 10"
WallThickness[b,c]	4.0"	8.5"	9.0"
Empty Weight[b] (tons)	~ 10	~ 10	~ 10
Floor Loading[b] (lbs/ft^2)	~ 2,800	~ 1,800	~1,800
ROM Cost Range Each[b] ($)	$30K – $40K	$15K – $25K	$8K – $14K

[a]Height includes overpack lid lifting features.

[b]The presented values are associated with reducing a 400 mSv/hr canister to contact-handled criteria (i.e., <2 mSv/hr).

[c]The top and bottom thickness are different than the wall thickness. In general, the bottom is thicker for structural reasons and the top is slightly thinner due to the lower dose rate from the canister top.

Since the limited overhead height in Building 7883 eliminates the use of a crane, a high-capacity forklift or similar equipment is necessary to move the overpacked canisters inside the facility. One potential lifting arrangement is shown in the left bottom illustration of Figure 3. A high-capacity forklift is equipped with a mast attachment that creates a saddle to secure the overpacked canisters during transport. The forks are driven through the fork guides until the overpacked canister is seated in the saddle. Hydraulically-operated arms are then closed around the overpacked canister for transport.

The high-density concrete overpacks have the largest diameter of the cylindrical overpacks included in the evaluation. Using the concrete overpacks as the limiting case (i.e., the least number per bay), a maximum of 48 overpacks can be loaded into each Building 7883 bay.

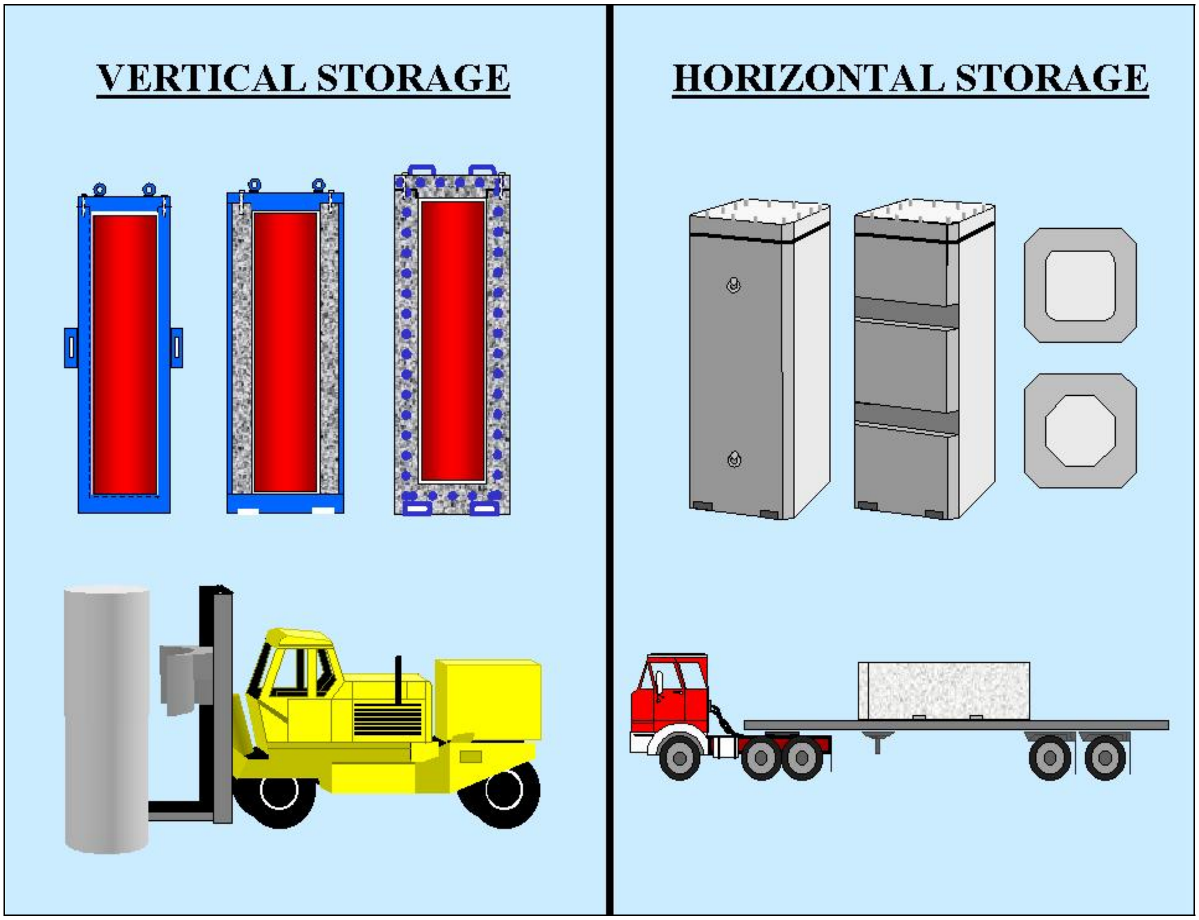

Fig. 3. Conceptual Shielded Storage Methods for 72B Canisters

Horizontal Overpacked Canister Storage

The WPF is designed to load canisters vertically into the RH TRU 72B shipping cask. The ideal interim storage overpack uses the same arrangement and equipment. Figure 3 presents one conceptual design (the "square overpack") that facilitates vertical loading and both vertical and horizontal storage. In addition to the end fork guides, the square overpack has one side surface with lift rings and the opposite side surface with fork guides. The lid of the overpack is bolted to the base. The section views in Figure 3 illustrate two possible inner cavity designs. The square overpack is loaded, transported, and stored vertically in a manner similar to the cylindrical concrete overpack. However, the square overpack could also be moved and stored horizontally. The square surface allows for stacking and the orientation flexibility may be helpful for using facilities with lower ceiling clearance. The disadvantages of the square overpack include additional fabrication cost (relative to the cylindrical design), alternate equipment needs for the WPF, and a potential lower storage efficiency.

Comparison of Storage Options Using the Existing Facilities

Figure 4 presents a qualitative comparison of the canister storage methods included in the evaluation. As demonstrated in Figure 4, each method has advantages and disadvantages. The vertical and horizontal unshielded methods offer excellent storage capacity but the initial cost, lead-time, potential radiation exposure, and compatibility with the planned operations in the WPF is not desirable. The horizontal overpacked method offers the same satisfactory storage and implementation characteristics of the vertical overpacked method but the additional cost and increased handling equipment for the WPF is undesirable.

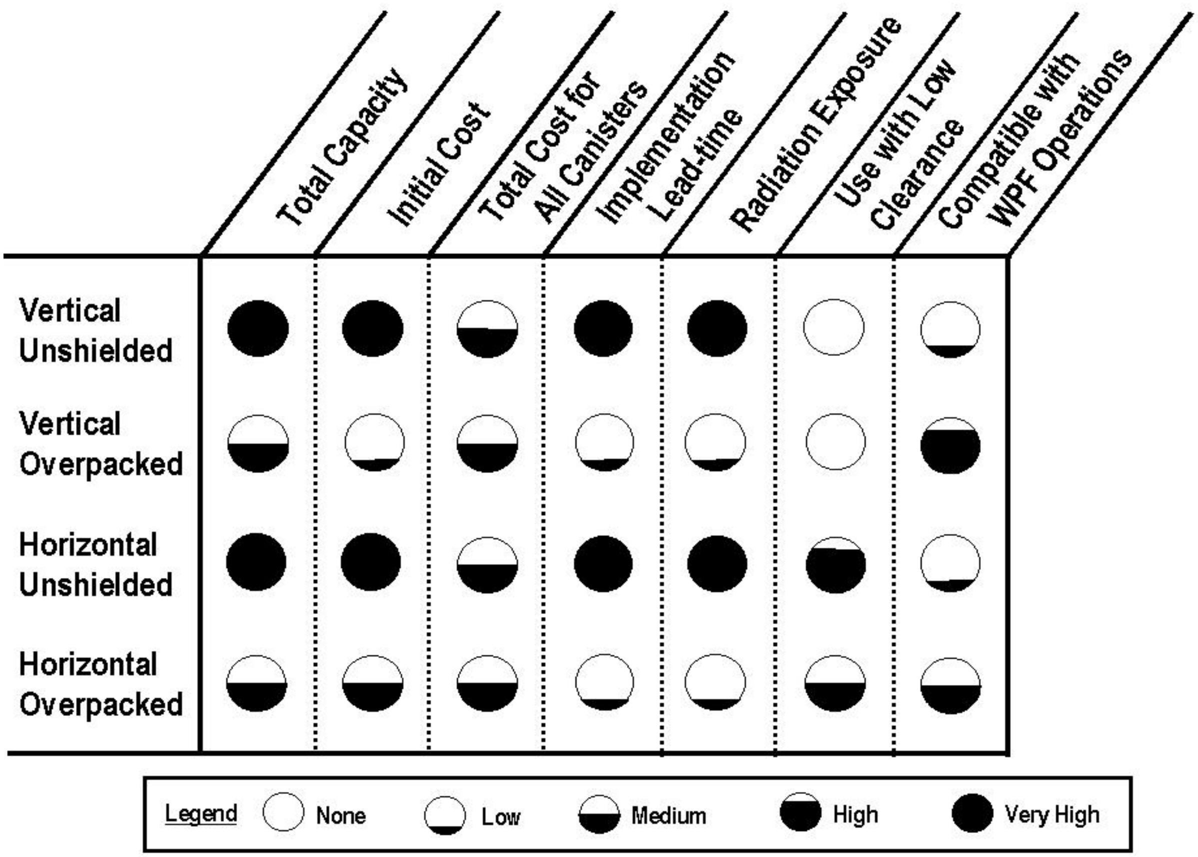

Fig. 4. Comparison of Storage Options for Using the Existing Facilities.

The vertical overpacked method offers the best combination of characteristics. The initial cost, lead-time, and radiation exposure is low. The compatibility with the planned WPF operations is high because the current plans for vertically loading canisters into the RH-72B shipping cask requires similar equipment. The major drawback for the overpacked approach (both vertical and horizontal) is associated with a large numbers of canisters (e.g., >300). For a large number of canisters, the cost of disposal for the empty used overpacks might be significant if the overpacks were considered radioactive waste. However, if the RH-TRU waste is packaged correctly, the overpacks should not become significantly contaminated.

In addition to storing canisters inside the existing facilities, the overpacked canister methods offer another advantage. With the proper environmental and physical controls, overpacked canisters may be approved for storage on outdoor pads. Pad storage offers a low cost approach with more flexibility for staging and other operations.

CONCLUSION

The DOE-ORO conducted an evaluation of storage options for the RH-TRU waste 72B canisters that may be generated in Oak Ridge, Tennessee prior to the WIPP being approved to receive and dispose of RH-TRU waste. The storage option that was determined to provide the most flexibility and compatibility with the least initial cost was the use of individual concrete shield overpacks that would be transferred onsite and stored in a vertical orientation. The design and construction of a devoted canister storage facility was determined to involve a significant initial investment that was not warranted when other incremental options exist.

FOOTNOTES

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