TECHNIQUES FOR EXHUMATION OF TRU WASTE APPLIED TO ABANDONED NONRADIOACTIVE HAZARDOUS WASTE

James R. Bishoff, EG&G Idaho, Inc.
Wallace J. Dodson, Kaiser Engineers, Inc.
George B. Humphreys, Kaiser Engineers, Inc.

Introduction

Established in 1949 by the Atomic Energy Commission (AEC) for the construction, operation, and testing of nuclear facilities, reactors, and equipment, the Idaho National Engineering Laboratory (INEL) occupies 894 square miles of semiarid plain in southeastern Idaho.

The Radioactive Waste Management Complex (RWMC) at the INEL contains approximately 2,000,000 ft^3 of buried transuranic (TRU) waste.[1] Figure 1 shows the condition of some of the waste buried in the early history of the RWMC. Figure 2 shows stacks of waste containing drums that were buried in 1968-1970.[2]

This paper will describe two concepts for retrieving the buried radioactive TRU waste at the INEL RWMC. It will then discuss the applicability of these concepts to the retrieval of nonradioactive hazardous wastes.

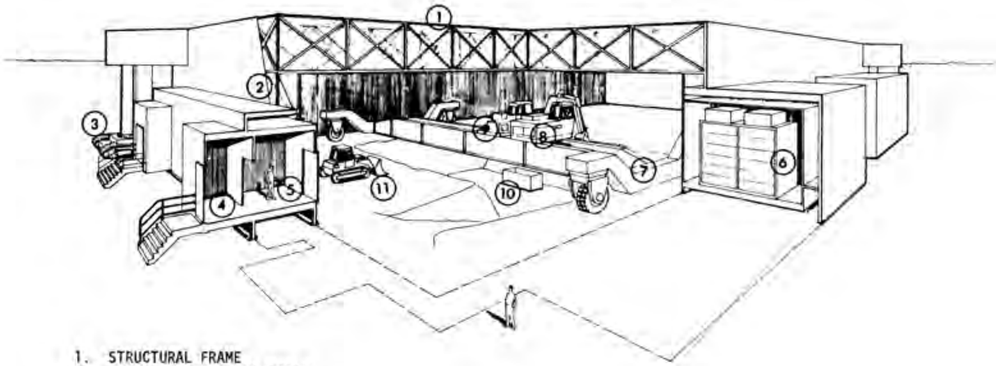
The two concepts are based upon design criteria that require 1) a double containment building to surround the retrieval operations and 2) a single containment building surrounding the retrieval operations.

Double Containment Building

The retrieval building (Fig. 3) would be a mobile, double-walled structure about 150 feet wide, 300 feet long, and 30 feet inside height. The main structure of the building would be between the ceiling and the roof in the form of a stressed-skin box built around a structural frame; the walls would be hung down and cantilever-braced from this top structure, with flexible joints placed periodically along the walls. This approach would provide an elastic structure with readily predictable flexibility capable of withstanding considerable unequal settling of supports during transport and "sitting"; also, the nonstructural walls can easily be cut out and modified to accommodate the various rooms and auxiliaries. For transport, four-point support at the corners would be provided; for "sitting," the four corners would bear on the ground; also, two points at the middle would bear. Middle-bearing would provide redundancy and would reduce deflections.

Fig. 1. TRU Waste Buried in 1950's.

Fig. 2. Initial Drum Retrieval Operations.



1. STRUCTURAL FRAME
2. DOUBLE CONTAINMENT WALLS
3. RETRACTIBLE CRAWLER
4. PERSONNEL AIRLOCK
5. PERSONNEL CHANGING ROOM
6. HEPA FILTERS
7. GANTRY BRIDGE
8. BACKHOE HYDRAULIC EXCAVATOR
9. GRADALL TYPE HYDRAULIC EXCAVATOR
10. STAINLESS STEEL WASTE CONTAINER
11. CRAWLER MOUNTED FRONT END LOADER

Fig. 3. Double wall radioactive waste retrieval system.

The roughly estimated weight of the building, as illustrated, is in the range of 1,500 to 2,000 tons, with soil-bearing pressures approximately 5,000 psf for travel and 2,500 psf for "sitting."

When sealed to the ground, with double flexible seals banked with sand, the retrieval building would provide double containment of airborne contamination. Air in the space between the outer and inner walls of the building (the outer zone) would be maintained at a pressure that is below atmospheric pressure; the pressure inside the building (the inner zone) would be lower still. Thus, air leakage would be inward, precluding the escape of airborne radionuclides into the environment. The successively lower air pressures would be maintained by two separate ventilation systems. All air removed by the ventilation systems would pass through a series of roughing filters and HEPA filters.

The four travel crawlers have a capacity of 400 to 500 tons each with a design footprint pressure of about 5,000 psf. They are electric-motor driven and mounted on a pivot with lifting cylinders. The crawlers turn only when lifted clear of the ground to avoid harsh skid-steering. They are capable of traveling in any direction.

Two production-transfer air locks with container decontamination capability (for waste transfer), personnel decontamination space, personnel air locks, emergency personnel exits, a backfill entry port and ventilation equipment, including bag house filters and HEPA filters, would be installed in the walls of the building.

A gantry bridge is provided as a working deck for two hydraulic excavators. It spans approximately 125 feet and is mounted on four large pneumatic tires, with four-wheel pivot steering so that it can advance for retrieval and can follow the building movement for relocation.

One of the hydraulic excavators is a back-hoe type with rotatable clam bucket, with an approximately 1-cubic-yard capacity. The digging depth is approximately 22 feet (below crawlers) and the reach is approximately 32 feet from swing center.

The second hydraulic excavator is a Gradall type, with a 1-cubic-yard shovel as the basic tool for forward-digging. The digging depth and reach is the same as the other excavator.

The excavated waste is placed in a stainless steel waste container approximately 4 feet by 4 feet by 7 feet long. The cover remains outside of the retrieval work area, and is emplaced in the decontamination room.

The waste containers are picked up by a crane system hung from the roof of the building. It has a lifting capacity of 10 tons and travels on a double-girder bridge approximately 270 feet long, carried by crosswise multiple runway truck beams at 25-foot centers.

Also included in the building are: a crawler-mounted front-end loader for placement of backfill, a soil compactor, a dust-suppression tank truck, a fire-suppression/emergency vehicle, and other miscellaneous maintenance and support vehicles.

All operations inside the building would be performed by workers directly controlling retrieval equipment (excavators, front-end loaders, etc.) from cabs that are isolated from the environment.

Workers performing walk-around functions during operations would wear bubble suits with breathing air from an external source. Equipment maintenance and cleaning of building walls and ceilings, prior to movement of the building, would also be performed by personnel wearing bubble suits. The equipment operators housed in enclosed cabs would wear sufficient protective clothing to permit walkaway escape if escape were necessary.

Single Containment Building

The retrieval building would be a movable tension structure 150 feet wide, 300 feet long, and 50 feet inside height. The building is constructed of extruded aluminum, wood, or cable arches integrally connected to an all-weather outer membrane. The tension structure provides an efficient and stable building with a free span coverage of the retrieval site. Figure 4 shows a tension structure supported with aluminum arches.

Access is provided by personnel air locks, emergency personnel exits, and a production transfer air lock for ingress/egress of equipment, supplies, and retrieved waste.

The building would be maintained at a subatmospheric pressure to prevent the escape of airborne contaminants into the environment. All air removed by the ventilation system would exhaust through both roughing and HEPA filters.

The retrieval concept for buried waste places an operator in a totally enclosed cab. The cab is designed to provide protection for the operator from airborne contaminants, direct radiation, and physical and chemical hazards. The equipment design is based on modification of existing available equipment. The modifications include positive pressure cabs and removable shielding.

Fig. 4. Typical tension structure, 120 ft x 240 ft, general warehouse (photo courtesy of Sprung Instant Structures, Inc.).

A typical retrieval would use an excavator, with a variety of buckets, as the primary retrieval mechanism. Supporting equipment would include a truck-mounted industrial vacuum system, cyclone precipitator, misting assemblies, container trailers, and vent hoods. Prior to retrieval of the waste, all loose soil from on top of and around the waste is removed with the vacuum system and packaged. The excavator retrieves and dumps directly into a waste container through a dump hood that is connected directly to an electrostatic precipitator. The precipitator provides an airflow velocity of at least 150 ft/min across the hood and exhausts through the building HEPA system.

In addition to ventilation, a mist ring surrounds the top of the hood and supplies a fine mist during actual dumping for additional dust control. Mist continues after the shovel has been dumped until all waste material has been placed into the container and the upper waste surface is damp. The hood is then placed over another container on the trailer in preparation for another dumping cycle. The containers are covered as soon as the vent hood is moved to the next container. When all the containers on the trailer have been filled, the trailer is moved and another trailer with empty containers is positioned behind the excavator.

Retrieval of Nonradioactive Hazardous Wastes

To demonstrate the applicability of the above techniques (which were developed for exhuming TRU wastes) to abandoned non-radioactive chemical wastes, it will be useful to consider a specific abandoned site. For this reason, the McColl site adjacent to Rosecrans Avenue in Fullerton, California (Orange County) has been selected as an example to illustrate the technique. It should not be inferred that exhumation of these wastes is necessarily required or is being recommended. Costs, exposure risks, and long-term effectiveness of the various alternatives available are among the many factors which will have to be evaluated before selecting the most appropriate remedial action program for the McColl site. Nevertheless, the techniques and systems described appear to merit serious consideration as one of the alternatives to be compared.

The McColl site is situated near producing oil fields in an area known as the Los Coyotes Hills. During World War II, the property was used as a disposal site for acid-sludge residues resulting from the refining of high-octane aviation fuel. During the 1950's and early 1960's oil field drilling muds were intermittently disposed of by covering the acid sludges deposited earlier in the sumps. The waste-acid sludges were thought to be permanently buried, but are now slowly percolating to the surface of the old sumps and giving off sulfur dioxide and other gases.

During the last decade, urbanization of the area has occurred and a number of homes in the $200,000 price range have been built within 200 feet of the disposal sumps. The site, shown in Fig. 5, consists of approximately 8 acres and holds an estimated 1,400,000 ft^3 of acid-sludge and drilling muds in disposal sumps, ranging from 15 to 30 feet deep. There are two distinct disposal areas. One area, known as the "ramparts" area, contains six sumps located on two terraces or benches. The other area comprises six more sumps located on the golf course adjacent to the residential housing. Thick tarry material is oozing to the surface at one point in the golf course.

An active state/federal investigation of the site and the wastes buried therein began in 1980 and continues. Analyses of surface and core samples indicate that heavy petroleum tars and sulfonation tars are present. Liquid hydrocarbons, aqueous wastes, asphalt-like material, and gas pockets appear to be present. Arsenic compounds also have been detected in high concentrations on the sump surfaces. In some places, the surface has formed a crust which, if disturbed, releases gases. In one test hole, sulfur dioxide concentrations of 38,000 ppm were measured. In addition to sulfur dioxide, other gases such as volatile organic compounds, thioethers, and other compounds having strong offensive odors have been detected.

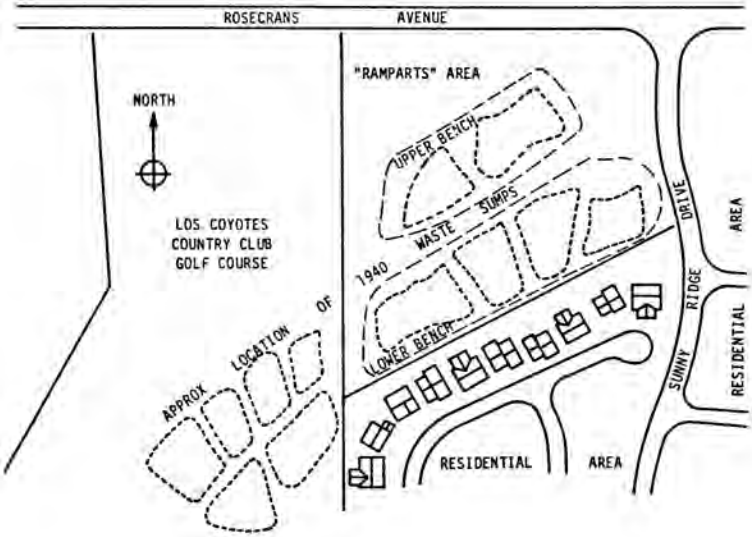


Fig. 5. McColl Hazardous Waste Site - Fullerton, California.

Three distinct types of movable structures that have been developed for the exhumation of low-level TRU waste or handling of doubly contained TRU waste could be considered for use in retrieving nonradioactive hazardous wastes. These are:

1. A double-containment retrieval building utilizing stress-skin metal walls built around a structural frame. The containment area would be maintained at a subatmospheric pressure to preclude the escape of untreated toxic gases.

2. A tension structure constructed of extruded aluminum, wood or cable arches integrally connected to an outer membrane which provides single containment. This type of tent-like structure also could be maintained at a slight negative pressure to prevent the leakage of untreated gases to the surroundings.

3. An air-support structure consisting of a coated fabric membrane to provide a movable enclosure. This type of structure would be held at a positive pressure differential of approximately one inch of water to support the membrane. A cable net could be used externally to restrain the coated fabric membrane.

Although the air-support structure would have the lowest erected cost (\$3.50 to \$5.00 per ft^2), it would also have an uncontrolled outleakage of 3,000 to 6,000 cfm. This type of structure has only been used as a weather shield while handling doubly contained TRU wastes. However, the gas outleakage might not be acceptable at the McColl site with its urban surroundings and nearby residences.

The double-containment retrieval building is the most expensive (approximately \$300 per ft^2) of the three types of structures. Furthermore, the double-containment feature (included because of the presence of plutonium in TRU wastes) probably cannot be justified for chemical hazardous wastes. Assuming that preventing the escape of untreated gases from the containment area will be an objective, the tent-like tension-structure (\$15 to \$25 per ft^2) appears to be the appropriate choice at present.

The California Department of Health Services, Hazardous Materials Management Section, is continuing investigations at the McColl site. During the first half of 1982, it is planned to erect an enclosure over a small portion of the site and measure actual concentrations of various gases released during excavation in one of the sump areas. The results of these tests should give a better indication of what containment may or may not be necessary, the gas concentrations, and extent of gas cleanups, if any, which may be required.

Some of the differences between the buried chemical hazardous wastes at the McColl site and the TRU wastes at INEL which might affect the exhumation techniques and equipment used are noted below:

1. The principal hazard from the low-level TRU wastes is dispersal of radioactive particulate matter; whereas corrosive liquids and gases are present at the McColl site in addition to solid hazardous wastes. The use of HEPA filters to control particulates probably would not be necessary at the McColl site, but other control equipment may be required to remove sulfur dioxide, particulates, and toxic or malodorous gases released by exhumation.

2. Materials for the tent and structural members which might be exposed to acid fumes would have to be carefully selected for their resistance to corrosive atmospheres. This is not a significant consideration for TRU waste exhumation. A number of membrane materials are available, including glass fiber fabrics coated with polyvinyl chloride or Teflon®, which appear to offer satisfactory corrosion resistance.

3. Separate breathing air supplies would have to be provided for operators in enclosed equipment cabs or for operators wearing protective suits. Materials for protective suits would have to provide chemical protection and a barrier against the intrusion of toxic liquids and gases.

4. Materials and lubricants used for the excavation equipment might have to be modified to provide adequate resistance to acid fumes inside the containment enclosure.

5. Protective clothing and breathing air supplies may be required for workers erecting the tent-like tension structure. This is because the construction activity could disturb the surface crust and release dangerous concentrations of corrosive and/or toxic gases. This factor could appreciably lengthen the erection and knockdown time.

6. The possible difficulty of decontaminating internal arches, bows, cables, etc., indicates that tension structures preferably have these structural components situated externally to the membrane.

7. The maximum width of the lower bench in the "ramparts" area is approximately 150 feet. The tension-structure concept developed for the exhumation of TRU wastes is 150 feet wide by 300 feet long. One manufacturer of tension-structures makes standard buildings in 90 and 120 foot widths. For the McColl site, the use of a tension structure enclosing a somewhat smaller area, such as 120 by 240 feet or 90 by 200 feet, would provide greater flexibility in covering the area.

8. At INEL the TRU waste retrieval program has been based on a ten-year campaign. At abandoned chemical hazardous waste sites such as McColl, it would be desirable to keep the remedial action program as short as possible, preferably a year or less. A shorter retrieval period would not only enhance community acceptance, but also reduce the exposure risks associated with a more protracted program.

9. Although working multiple shifts could appreciably shorten the remedial action program, objections by nearby residents to noise and truck traffic might make it difficult to work more than one 8-hour shift per day.

10. The different character of the TRU wastes and the chemical hazardous wastes could appreciably affect the achievable excavation and removal rates. The TRU wastes buried at INEL are in rusted drums and disintegrating boxes which slow the retrieval operation because of the somewhat fragile condition of the containers. Although fragile waste packaging is not a factor at the McColl site, the relative proportions of the various solids, liquids, gases, sludges, and tarry material have not yet been established. Excavation of tarry material could be a slow operation if it tends to stick to excavation tools. To excavate 1,400,000 ft^3 (50,000 + cubic yards) of material in six months, an average retrieval rate of 50 cubic yards per hour would have to be achieved. This is almost three times the projected retrieval rate for TRU wastes using a backhoe with a 3-cubic-yard bucket.

11. It may be necessary not only to use corrosion resistant materials for constructing the waste containers but also to make them gas tight. This would reduce the release of toxic gases or gases having strong, offensive odors along the transport route.

It is estimated that the capital cost of the tent-like tension structure, excavation and backfill equipment, and air pollution controls would be approximately $3.8 million (in 1982 dollars). The air pollution control system is assumed to include a lime or soda ash scrubber for control of sulfur dioxide and particulates, and a carbon adsorption system for removing toxic and malodorous organic gases. The estimated operating costs are $1.6 million. This assumes that approximately six months would be required for actual excavation operations and seven to eight months for setting up and breaking down the tension structure. It appears that the tension structure would have to be situated in about eight locations to adequately cover all the abandoned sumps. This would entail a total remedial action campaign of 13 to 14 months. Operating costs include operating labor, set-up and breakdown crews, utilities, erection equipment usage, and chemicals consumed. The total estimated capital and operating costs of $5.4 million correspond to a unit cost of $110 per cubic yard (based on excavating all 50,000 cubic yards of buried wastes). This excludes the cost of transporting, treating and/or disposing of, the wastes removed, because the ultimate disposal site and method of treatment or disposal have not yet been determined. There is a possibility that the tent-like tension structure, air pollution controls, excavation and backfill equipment, could be reused at other abandoned hazardous waste sites containing similar wastes. It should be noted that the actual remedial action program developed for the McColl site may involve a combination of methods and steps such as excavation, in-situ immobilization, slurry walls, and clay caps, as well as leachate collection and treatment, depending on the nature and risks presented by the wastes in each of the sump areas.

Acknowledgment

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