CONTAMINATION CONTROL DURING TRU WASTE RETRIEVALAT THE IDAHO NATIONAL ENGINEERING LABORATORY

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ABSTRACT

This paper discusses contamination control during retrieval of buried transuranic (TRU) waste at the Idaho National Engineering Laboratory (INEL). Retrieval of buried TRU waste at the INEL and final deposition at a federal repository is one of the alternatives being analyzed for a permanent solution to the buried waste. The defense related buried waste originated primarily at the Rocky Flats Plant and is mixed hazardous waste. The main contaminants to be contained and controlled are plutonium and americium compounds. Strategies for contamination control during retrieval have been developed and involve maintaining moisture control in the dig face and air flow in the inner containment structures to eliminate airborne contaminants. An additional integral part of contamination control is the fast detection of airborne alpha emitting radioisotopes in a nonlaboratory environment. Activities at the INEL to examine contamination control have included separate effects testing in the glove box scale and construction of a full scale test pit involving simulated waste with tracers for future retrieval investigations and contamination control studies.

INTRODUCTION

This paper discusses contamination control during retrieval of buried transuranic (TRU) waste at the Idaho National Engineering Laboratory (INEL). Between 1952 and 1970 over 56,000 m^3 of primarily Rocky Flats Plant (RFP) generated TRU waste was stored at the INEL in shallow land filled pits and trenches. The main contaminants to be controlled are compounds of plutonium and americium which are contained in the waste stream from RFP. Since these substances are extremely toxic, alpha emitting, extremely small sized, and extremely mobile (highly charged), airborne concentrations must be kept to a minimum to effectively eliminate personnel uptake during retrieval operations.

One of the options for final disposition of this stored waste is to retrieve the waste and repackage it for permanent storage at a federal repository. In the past, retrieval demonstration projects have been performed at the INEL(1), but only on an "archeological dig" basis. These studies concluded that a strong TRU waste contamination control plan is mandatory for a production scale excavation. Since retrieval is one of the main options for the INEL waste, contamination control studies were initiated at the INEL in FY-1988 and are continuing in FY-1989 which will culminate in a preliminary and final design of a contamination control subsystem for retrieval.

Discussed first in this report are the contamination control studies completed in FY-1988 which included library searches, separate effects testing in a glove box scale, and construction of a full scale simulated (cold) test pit for cold retrieval operations. Next, current activities involving strategies for contamination control and conceptual design concepts for apparatus are discussed. Finally, future plans for contamination control studies at the INEL will be discussed.

CONTAMINATION CONTROL STUDIES AT THE INEL DURING 1988

Studies related to contamination control during retrieval included: (a) a literature search involving overall examination of available contamination control techniques and detection of contaminants, (b) construction of a full scale simulated waste pit with rare earth tracers to simulate plutonium, and (c) basic glove box scale experiments to examine the respirable fractions of dust existing in the INEL soil. Findings from each of these areas are summarized below.

Available Contamination Control Techniques

A multitude of plutonium/americium contamination control techniques and detection schemes have been examined for application during retrieval(2). Many of these techniques have potential for contributing to contamination control; however, these concepts require separate effects testing in actual INEL soil types to prove effectiveness. The most promising concepts are briefly discussed below:

Chemical soil wetting agents and stabilizers (dirt fixatives) are widely known and have been used routinely in many different areas of industry for dust suppression. These materials could be sprayed onto the area behind the dig face (i.e., the area where the retrieval equipment passes over), and on the dig face, thereby greatly decreasing resuspension of fine dust particles.

Misting systems have been shown to be very effective in the reduction of airborne particulates in the mining and milling industry. There are a number of different compositions which range from water to chemical micro-foaming agents that can be used in misting systems. For misting

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systems the cost of application is low and protection factors high.

Ground mats have been used effectively at the INEL, at other DOE laboratories, and in the mining industry. Characteristics that are of concern in TRU waste retrieval are durability on a rocky surface, ease of decontamination, and compatibility to volume reduction techniques.

Laminar flow ventilation systems have been widely used in laboratory hood enclosures and low particulate concentration "clean rooms". The principle of this operation is to have all the air in the room move in a singular (plug flow) body with little or no lateral or turbulent mixing.

Monitoring of plutonium and americium contaminants in the presence of natural uranium and thorium progeny is an evolving technology. Alpha liquid scintillation techniques and constant air monitors are being advanced at the INEL specifically in detection technology and signal processing algorithms. These advances will enhance the maximum permissible concentration (MPC) of plutonium/americium detection limit such that the devices can be used in other laboratory applications with a "fast" (on the order of one hour) turnaround of information.

Electropolishing of waste retrieval equipment dig surfaces may minimize the amount of contamination that would become imbedded in surface micropores. Also, operating scenarios such as retrieval rates should include contamination control as a goal.

Due to the emission of alpha particles and stripping of electrons, plutonium/americium particles become highly charged. Electrostatic devices to attract airborne plutonium/americium may prove to be useful tools for airborne contamination control. However, as this technique is still in its infancy it will require more development to determine its full potential.

All of these "contamination control" techniques are promising; however, if retrieval becomes the option for the buried TRU waste at the INEL, contamination control will continually be upgraded as new technology becomes available. In this manner, retrieval rates may be increased and safety enhanced.

Construction of Simulated TRU Waste Pit for Future Contamination Control Studies

A full scale simulated TRU waste pit was constructed to provide a test bed for retrieval technique studies and contamination control studies. Contamination control will be examined by monitoring the spread of rare earth tracers that were emplaced in the waste forms to simulate plutonium/americium.

The cold test pit consists of five basic zones including over 450,000 kg of simulated waste. These different zones are as follows: (a) a large object zone consisting of 0.9 m diameter tanks and 1.2 m x 1.2 m x 2.4 m concrete vaults and a variety of stacked and randomly dumped drums; (b) a stacked box zone of 60 - 1.2 m x 1.2 m x 2.4 m boxes; (c) a stacked 0.2 m3 drum zone of approximately 1000 drums; (d) a random dump box and drum zone with 12 - 1.2 m x 1.2 m x 2.4 m boxes and about 120 0.2 m^3 drums; and (e) a random dump drum zone with about 360 0.2 m^3 drums. The layout of the pit is shown schematically in Fig. 1. Figure 2 is a photograph of the completed stacked box and stacked drum region, and Fig. 3 shows the random dump box and drum region and the random dump drum region under construction. Earth berms were placed between the various regions of the pit to separate the waste zones into distinctive zones. In the random dump zones, waste forms were dumped over the edge and backfilled with soil.

The simulated waste forms were typical of the waste generated at the RFP which is the primary contributor to the buried TRU waste inventory at the INEL. These waste forms included metal scraps (I-beams, pipes, pumps, laboratory equipment), glass, cloth, paper, wood, asphalt, concrete, and simulated sludge material. The waste forms were placed in boxes and drums made of cardboard. Cardboard was used to promote rapid deterioration of the containers in an attempt to simulate over 30 years of deterioration in original waste containers. The cardboard containers were also sprayed with water during the backfill operation which accelerated the deterioration process. In addition, about 5% of the drums were metal to simulate drums that have not deteriorated.

Rare earth tracers were placed among the simulated waste in each container. A specific rare earth tracer was used in a specific zone. The rare earth tracers included neodymium, terbium, ytterbium, and dysprosium. These tracers, while not typical of plutonium (Pu) behavior, should provide qualitative information on contamination movement with the dust generated by the retrieval operation. In addition, these rare earth tracers exist in extremely low concentrations in the INEL soil and were emplaced in the waste forms at ten times background. The filled and backfilled pit (completed July 1988) will be allowed to age for at least one year prior to retrieval experiments.

During simulated retrieval operations in the cold pit, the spread of the rare earth tracers will be monitored by using high volume air filtering systems and smears. The filters and smears will be neutron activated in an INEL test reactor, counted, and analyzed for ppm of the tracer. This will be repeated for a variety of retrieval techniques and contamination control techniques including air sweep hoods, misting systems, and soil fixants. This data will be documented as valid and defensible data.

Separate Effects Glove Box Studies

Experimental contamination control studies were conducted on a glove box scale with actual INEL soil spiked with the rare earth tracer dysprosium oxide(3). The objectives of these initial studies were to: (a) develop a glove box apparatus, including instrumentation, (b) characterize air flow rates in the glove box which simulates a laminar flow ventilation system in the retrieval building, (c) perform initial cold simulated retrieval experiments with dysprosium tracers to (1) test a measurement systems response and performance (this measurement system response data can be applied in the assessment of future contamination control experiments including the cold test pit described before), and (2) determine whether the tracer moves with

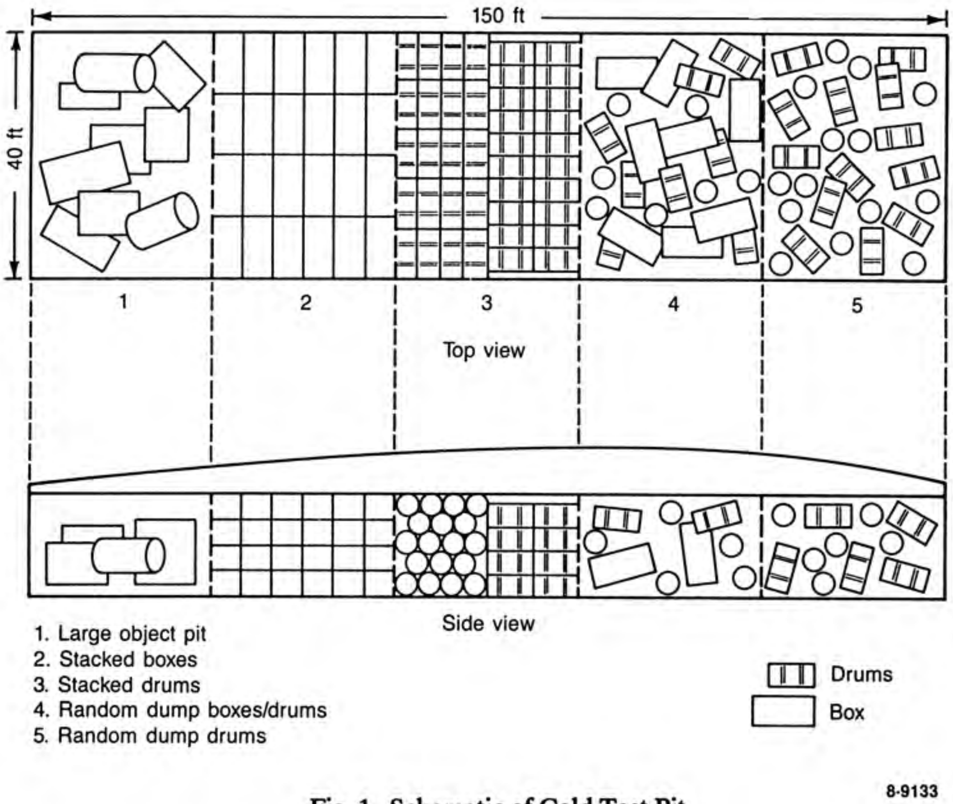

Fig. 1. Schematic of Cold Test Pit.

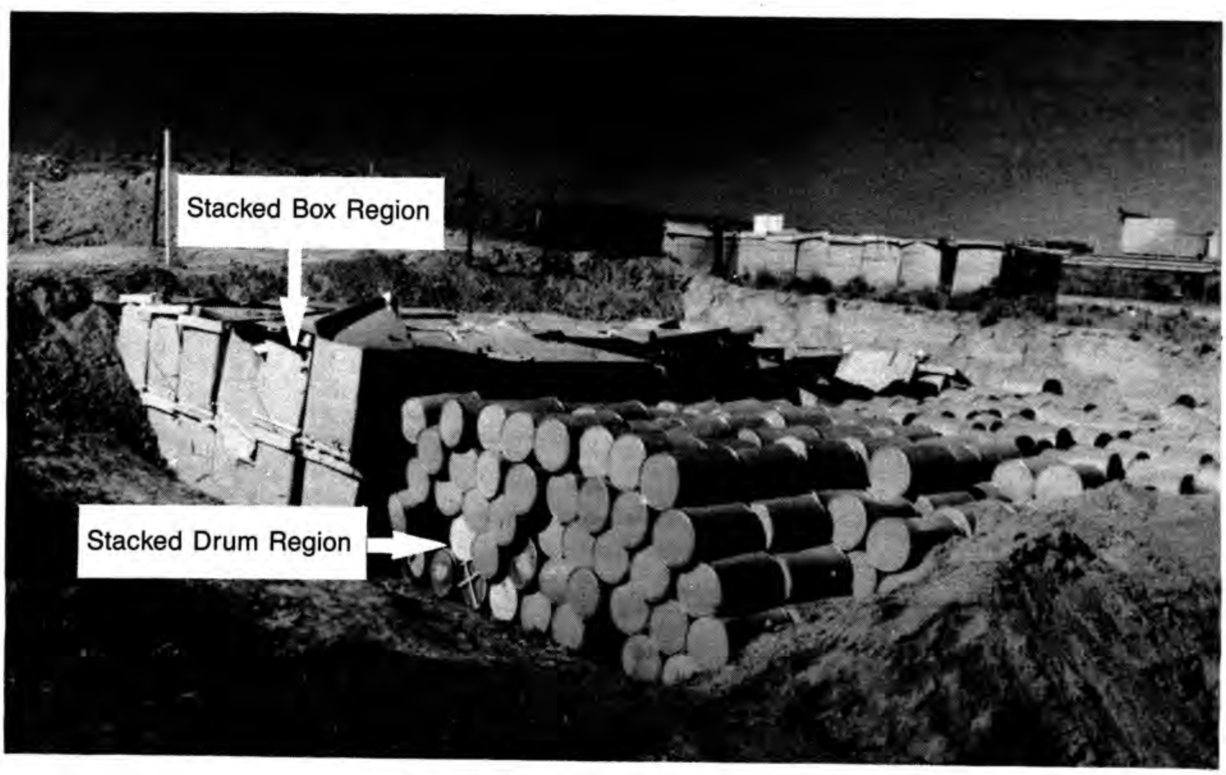

Fig. 2. Cold Test Pit Stacked Box and Stacked Drum Region.

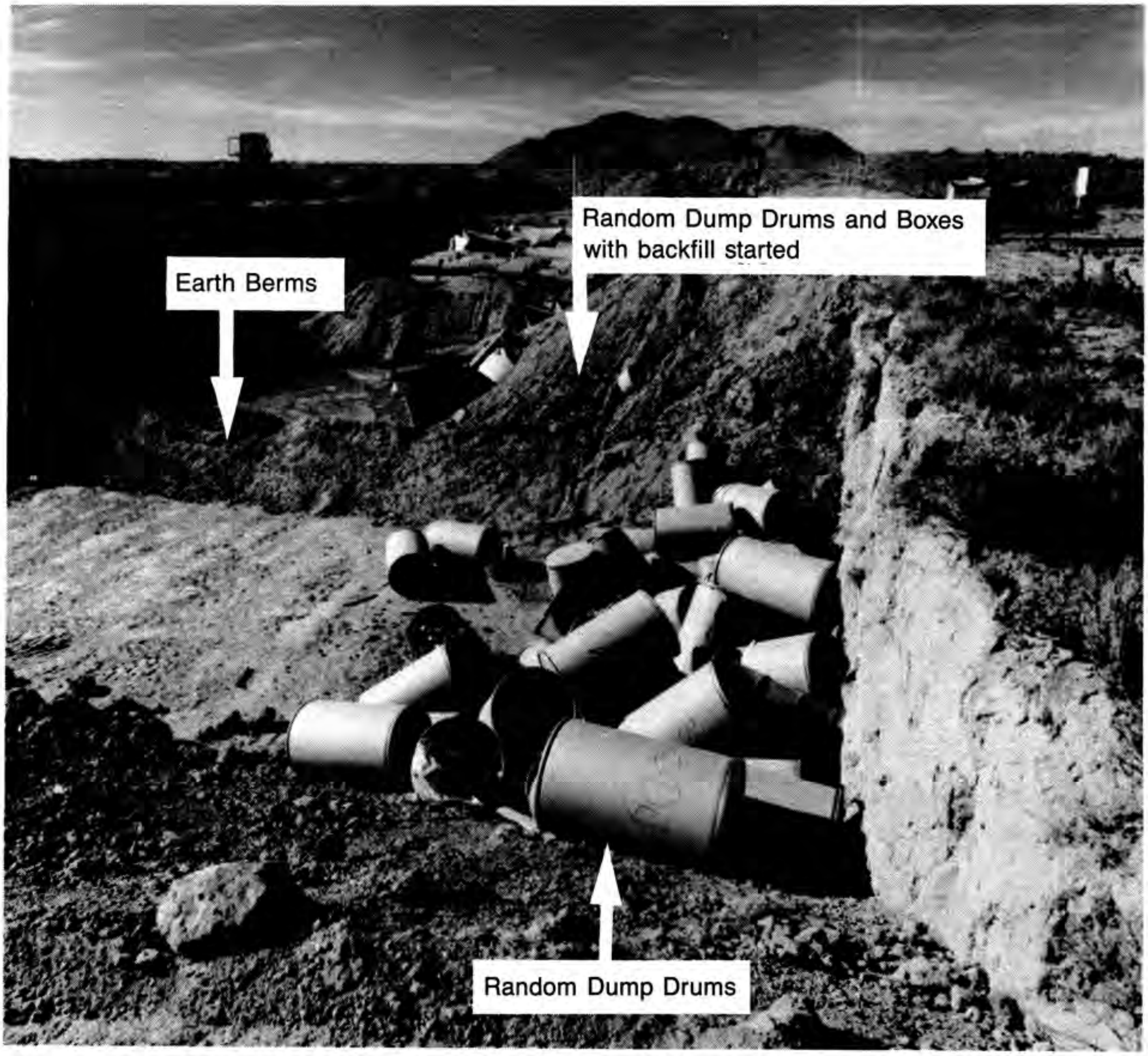

Fig. 3. Cold Test Pit Random Dump Drum and Box Region and Random Dump Drum Region.

the small respirable soil particles or with the larger non-respirable soil particles. (The implication for this result effects safety and operating limits for manned entry for routine maintenance using bubble suits.)

A plexiglass glove box apparatus was developed and is available for conducting scaled contamination control studies. The glove box has a removable/sealable lid, inlet and outlet ports for air flow, three glove ports, and a 0.03 m^3 space for creating simulated dig faces. Instrumentation for the glove box consists of five EPA cyclone samplers which separate respirable and nonrespirable dust from airborne particles. Other sampling techniques consisted of standard smears and cutouts taken from the filter paper which lined the bottom of the glove box.

A laminar flow ventilation system is being considered as a contamination control technique during retrieval in the vicinity of the dig face. The glove box was configured to simulate the basic elements of the laminar flow ventilation system. Flow was supplied by a standard high volume air sampling system connected to the outlet duct of the glove box. Air flow patterns within the glove box were characterized by using a hot wire anemometer probe extended into the box via the ports. Three basic flow patterns were found in the box, including a region of measurable linear velocity, regions of zero linear velocity, and regions of zero linear velocity but some turbulence, as shown in Fig. 4. With the air flow on, the nominal velocity of air in the regions of measurable flow was 18-30 m/min which is typical of expected flows in an actual laminar ventilation system. However large regions of the glove box had zero linear velocity as shown on Fig. 4. Regions directly above the entrance and exit duct and a region near the dig face were included in this stagnant region. This is an important result because air flow

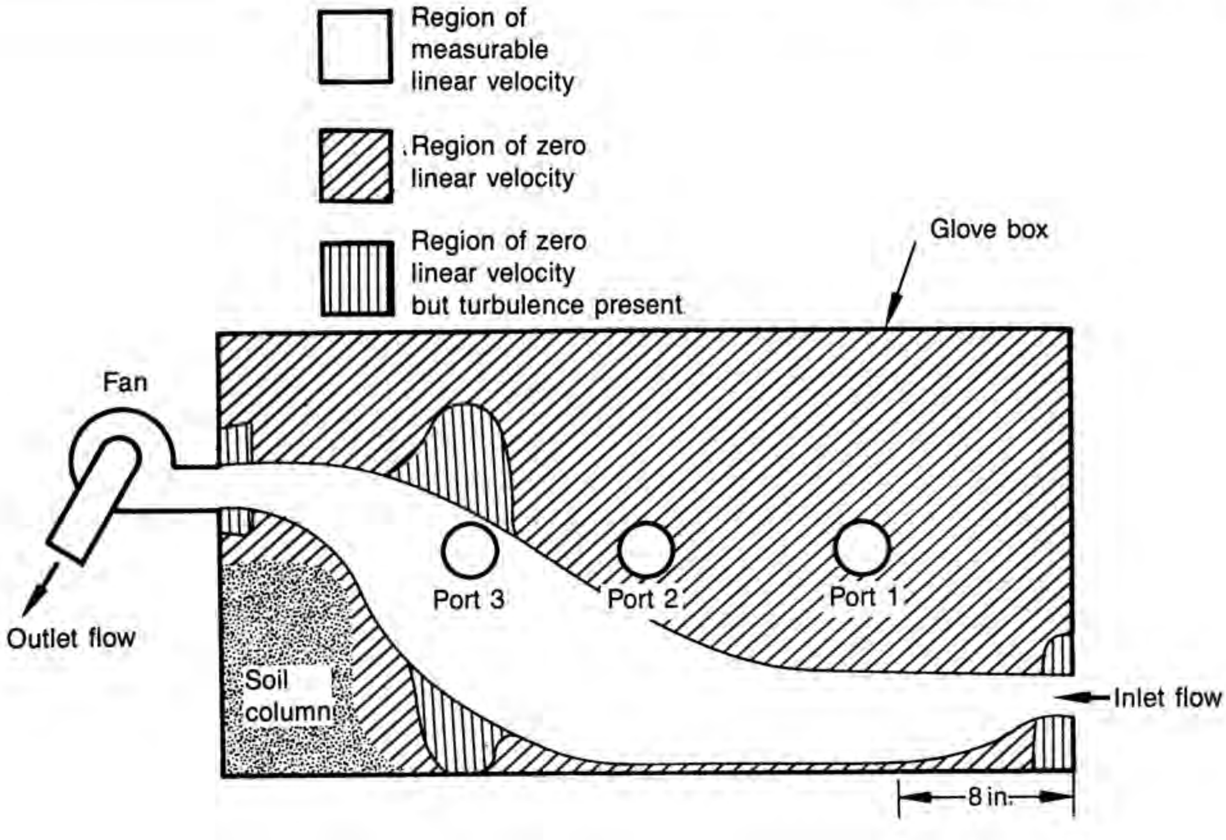

Fig. 4. Linear Velocity Characterization in the Glove Box Scale.

across a dig face tends to dry out the surface and promotes dust generation during retrieval.

Three excavation experiments were performed in the glove box under stagnant air conditions which involved different excavation techniques and moisture content in the soil column. Airborne dust was collected with the EPA samplers and separated into respirable (0.45 - 10 micron sized particles) and nonrespirable (10-50 microns). The obvious result was that increasing the soil moisture content decreases airborne activity in both respirable and nonrespirable fractions. Collected airborne samples were placed in polyethylene vials, activated in a reactor and counted for dysprosium content. Dysprosium was found in every sample analyzed but varied in concentration with moisture content of the soil column and excavation technique. Increasing moisture content in the soil decreased the concentration of dysprosium in the collected respirable samples. The dysprosium concentration of the nonrespirable samples was less than in the respirable samples as well as the host soil. The dysprosium concentration in the respirable samples and the host soil were similar, while the nonrespirable samples had concentrations that were about 5% of that found in the host soil. From these studies it can be concluded that proper simulation of the movement of plutonium during retrieval depends on four factors: (a) soil size distribution, (b) moisture content, (c) physical and chemical properties of the contaminant (plutonium) or simulated contaminant (dysprosium), and (d) excavation techniques. These glove box scale experiments involving dysprosium do not necessarily represent the behavior of actual RFP aged plutonium in the soil. For instance, RFP "aged" plutonium may move more with the larger more respirable fractions as suggested by earlier studies(4,5). Therefore, further testing with actual Pu contaminated soil from RFP mixed with INEL soil is mandatory to resolve the differences in these results.

CONCEPTUAL DESIGN FEATURES OF A CONTAMINATION CONTROL SUBSYSTEM FOR RETRIEVAL

A conceptual design of a contamination control subsystem for retrieval has been developed. The object of the contamination control subsystem is to minimize and monitor the uncontrolled spread of plutonium and americium contaminated particles emitted from the waste pit. The primary mechanisms for spread of the plutonium oxides and other compounds in the waste is through attachment to small particles of soil and debris (dust) which can be spread by mechanical agitation due to excavation/moving and other air currents within the primary building. Therefore, contamination control is intimately connected to dust suppression within the primary building. To accomplish dust suppression, the design includes three main features: waste region moisture control, primary building airborne contamination control by laminar flow air movement, and effective monitoring of contamination spread.

The INEL pits and trenches are expected to naturally have considerable moisture content (see Table I as an example of INEL bore hole data). For this example the range of moisture varies between 9 and 45% by mass, and below 1.5 m (the average depth of the overburden) the moisture content is generally above 15%. Where necessary, fixants will be added to the soil to maintain sufficient moisture to reduce dust spread. In addition, for areas behind the dig face numerous techniques are available for dust suppression, including mobile fixant spray systems and vacuum systems.

TABLE I

TYPICAL SOIL MOISTURE CONTENT FOR INEL

Depth (m)	Moisture Content (% by Mass)	Texture
0	--	Silt, very dry
0.5	9.0	Silt, dry
1.0	19.0	Fine sandy silt, moist
1.5	14.9	Fine sandy silt, moist
1.8	--	Sandy silt, moist
2.3	26.3	Clayey silt, moist
2.8	23.5	Fine sandy silt, moist
3.3	27.6	Fine sandy silt, moist
3.9	18.9	Silt, moist
4.4	23.2	Sandy silt, very moist
4.9	45.4	Clayey silt, very moist, water dripping from sampling tube, samplin tube hit basalt at bottom

An air sweep hood over the immediate dig face and areas directly behind the face will provide a general primary building air flow at a nominal linear velocity of 15 m/min. Any contamination that becomes airborne should be swept from the excavation area to a filtration system (prefilters, HEPA filters, and charcoal filters) where it will be removed before air is exhausted to the atmosphere.

To monitor the spread of plutonium contamination, alpha CAMs (Constant Air Monitors) will be used to measure airborne plutonium concentrations, and remote smears with alpha liquid scintillation will measure surface contamination. The monitoring subsystem will be a "fast turnaround" system that allows "less than an hour" analysis of airborne and surface TRU radionuclide contamination within the primary.

CONCLUSIONS AND FUTURE PLANS FOR CONTAMINATIONCONTROL STUDIES AT THE INEL

A large variety of techniques exist for controlling the spread of plutonium/americium contamination during retrieval. A basic conceptual design has been developed which involves maintaining moisture control in the waste forms, maintaining laminar flow ventilation in the inner containment, and developing fast turnaround monitoring capability. Adopting existing techniques for INEL conditions will require some additional separate effects testing.

Current plans at the INEL for contamination control studies include: (a) performing separate effects glove box experiments to choose fixant and misting agents and dust suppression agents as well as determine how RFP plutonium/americium moves with airborne dust particles, (b) determine migration of plutonium particles against laminar air flow (for air sweep hood development), (c) performing preliminary and final design on a contamination control module to disperse fixant and misting agents, and (d) alpha CAM and alpha liquid scintillation development for fast turnaround monitoring.

In the future, it is planned for the cold test pit to be excavated and the spread of the rare earth tracers to be monitored with and without contamination control techniques. Finally a demonstration of retrieval is planned for an actual INEL buried TRU waste pit for which contamination control will also be demonstrated.

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