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Decontaminating Lead Bricks and Shielding

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Abstract

Lead used for shielding is often surface contaminated with radioisotopes and is therefore a RCRA D008 mixed waste. The technology-based standard for treatment is macroencapsulation. However, decontaminating and recycling the clean lead is a more attractive solution.

Los Alamos National Laboratory decontaminates material and equipment contaminated with radioisotopes. Decontaminating lead poses special problems because of the RCRA hazard classification and the size of the inventory, now about 50 tons and likely to grow substantially because of planned decommissioning operations. This lead, in the form of bricks and other shield shapes, is surface contaminated with fission products. One of the best methods for decontaminating lead is removing the thin superficial layer of contamination with an abrasive medium under pressure. For lead, a mixture of alumina with water and air at about 40 psig rapidly and effectively decontaminates the lead. The abrasive medium is sprayed onto the lead in a sealed-off area. The slurry of abrasive and particles of lead falls through a floor grating and is collected in a sump. A pump sends the slurry mixture back to the spray gun, creating a continuous process.

The process generates small volumes of contaminated lead slurry that can be solidified and, because it passes the TCLP, is not a mixed waste. The decontaminated lead can be released for recycling.

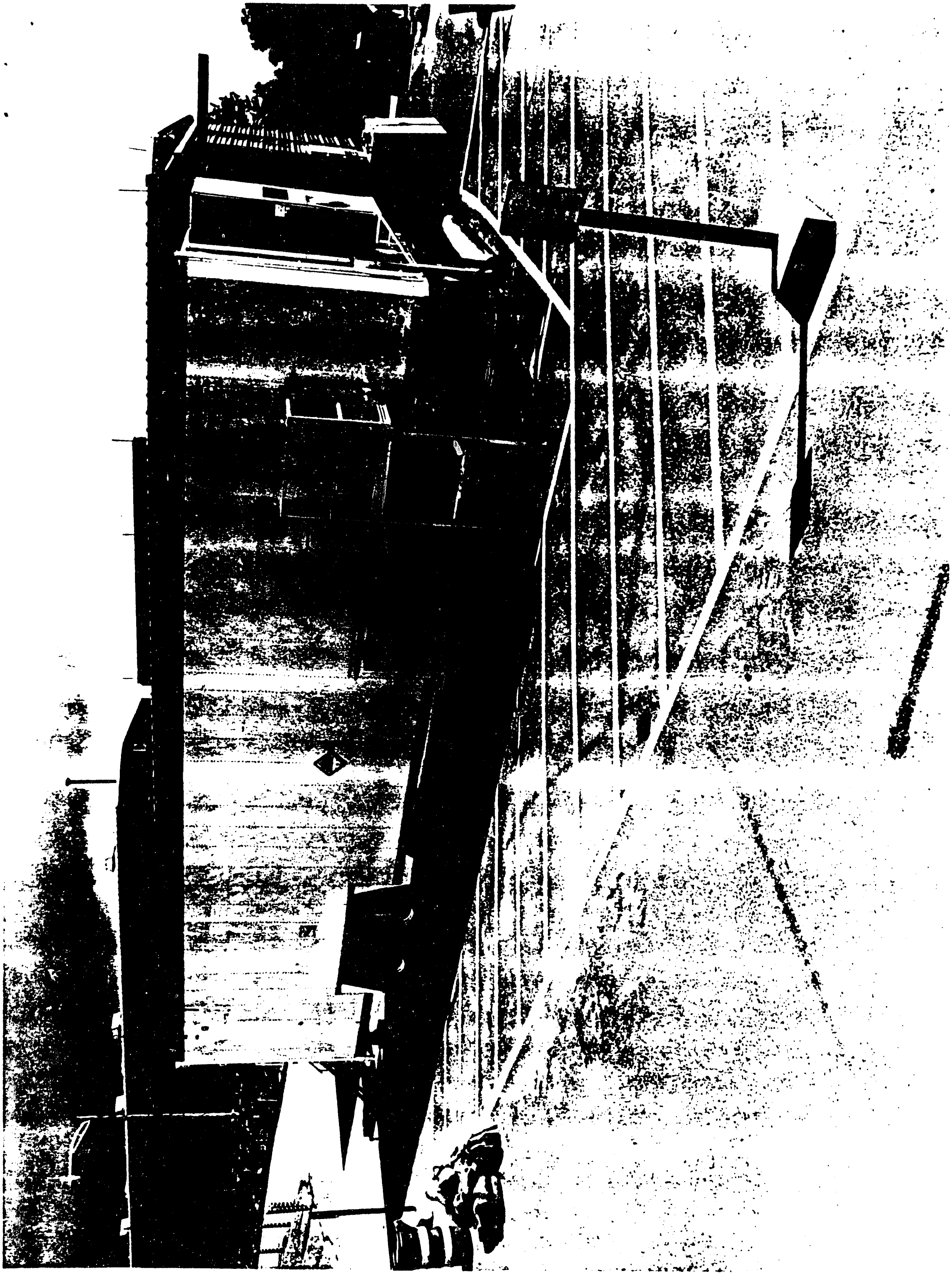
INTRODUCTION

Lead is often used as shield against radiation. At Los Alamos National Laboratory (LANL), decommissioning operations have produced about 50 tons of lead which is surface contaminated with fission radioisotopes, including Cs-137, Co-60, Sr-90, and possibly Eu-152 and Y-90. Most is in the form of bricks, although there are also some sheets. Future planned decommissioning operations will substantially increase this inventory.

Radioactive lead is a RCRA D008 mixed waste. The technology-based standard is macroencapsulation. However, because the TCLP test requires that the waste be reduced to pieces smaller than one centimeter, macroencapsulation still produces a mixed waste.

Decontaminating and recycling the lead is, obviously, a much more attractive option. LANL's equipment decontaminates lead by removing a thin superficial layer using an abrasive media of water, alumina, and air. This slurry version of sandblasting is conducted at low pressure and considerably reduces airborne lead and radioactivity. The volume of effluent is minimal and can be rendered nonhazardous.

The equipment is mounted in an enclosed trailer, which can be moved and operated at the decommissioning site to avoid packaging the contaminated lead (Fig. 1).



BACKGROUND DATA

In the late 1980s, tests on decontamination of lead were run by a private contractor for the Department of Energy at Oak Ridge National Laboratory (ORNL). Various techniques were tested, including high-pressure wet sandblasting and high-pressure water blasting. However, the low-pressure blasting (30-40 psig) with a mixture of fine alumina, water, and air gave the best results (Fig. 1). This medium at this pressure is sufficiently abrasive and removes only a few mils of lead; decontamination to releasable limits was easily reached. The abrasive medium was also fully recycled.

One effluent produced is the used alumina--when it has lost its abrasive property--mixed with radioactive lead. During the tests, one 55-gallon drum of this waste was produced every three months. Generation rates will vary with the level of use of the equipment, which was not reported, but effluent generation should in any case be low. This effluent was solidified in cement, although it seems that no TCLP was run to determine whether the waste was not hazardous.

When decontamination is completed, the lead shapes are washed with clean water. This water becomes contaminated with fine lead particulates. Most can be removed by settling and, when filtered through a 1.5 μm filter, the residual lead concentration was about 0.01 mg/l. Approximately 55 gallons of this effluent were produced per day.

Decontamination rates ranged from 0.6 ft^2/min. to 2 ft^2/min. However, these rates do not include unpacking, staging, surveying the clean bricks, packaging, treating effluents, and maintaining equipment; the actual rate is estimated to be about 0.1 ft^2/min. of total operating time.

EQUIPMENT DESCRIPTION AND OPERATION

The equipment purchased is a 45-foot enclosed trailer divided into three compartments.

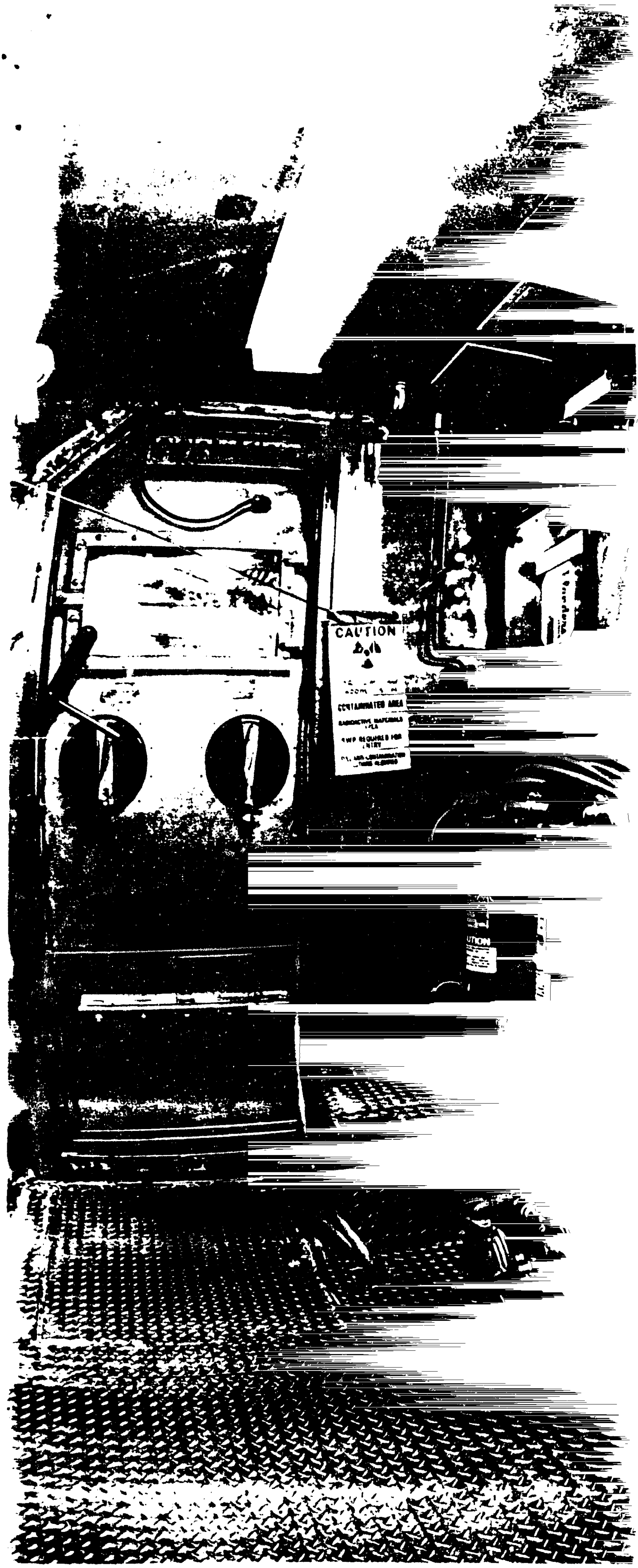
- The forward control room area, approximately 11 ft x 7.5 ft, which contains electrical controls, operator clothing change area, HEPA filter, and glove ports for decontaminating small parts. The small parts are located in the main blast booth (Fig. 2).

- The staging area, about 16 ft x 7.5 ft, located at the rear of the trailer (Fig. 3). An overhead hoist can extend 4 ft beyond the rear bumper on a rolling beam. It has a capacity of two tons. Parts to be decontaminated can be deposited on a cart on rails. This area also has a mixer to mix the sump waste with cement.

- Personnel access the main blasting booth through the control room (Fig. 4). Waste on the cart is rolled in from the staging area through two large double doors. The booth is equipped with a deadman blasting gun, breathing air connections, a cyclone to separate the solids from the liquid, a small parts table, a water filter, and push-button controls. The floor is stainless steel grating to let the slurry drain into the sump, which has secondary containment.

The exhaust from all areas is HEPA filtered. Heating and air conditioning provide comfortable working conditions. Walls, ceilings, and floors are made of 304 stainless steel for easy decontamination. Safety features prevent operating the decontamination equipment when the access doors to the blasting area are not hermetically shut or when the room pressure is insufficiently negative.

The slurry of abrasive and water is pumped from the sump by a rubber-lined vertical sump pump to the blasting gun, where it is mixed with compressed air at about 30 to 40 psig. The gun blast is directed at the piece to be decontaminated. The slurry drains through the grated floor and into the


CAUTION
CONTAMINATED AREA

sump and is recycled through the gun. At the end of the decontamination operation, a clean water spray is used to clean up the piece.

When the abrasive media must be discarded, the slurry is sent through a cyclone which separates the liquid from the solids. The heavy underflow slurry is then mixed with cement in a 30- or 55-gallon drum using a propeller and an air motor mounted on an air-operated lifter.

The excess water, after being allowed to settle, is pumped with an air-operated diaphragm pump through a 10-µm filter and a 1-µm cartridge filter and then into a drum. It is then discarded to the Radioactive Liquid Treatment Plant, a wastewater treatment plant that treats radioactive water generated facility wide. If soluble lead is present, a precipitating reagent such as sodium hydrosulfide can be used.

The trailer can be used for decontaminating various low-level contaminated parts and can be moved on-site as long as electric power is available. A skid-mounted electric air compressor and the breathing air unit are also transportable. Small quantities of fresh water must be available.

REGULATORY REQUIREMENTS

When lead can be decontaminated and reused, it is not a waste and is not subject to RCRA regulations such as for storage; and treatment is a recycling operation. There are many potential users for this lead at LANL. When decontaminated to free release, the lead could also be sent to a smelter.

When exhausted, the abrasive slurry is a waste containing radioactive lead. Therefore, it is a mixed waste. Solidification in cement is the technology selected by LANL. However, if the solidified slurry does not pass the TCLP, it still is a mixed waste, and finding a landfill for disposal is difficult. The TCLP, of course, requires the cement to be crushed, which exposes some of the lead. Solidification tests were run at laboratory scale on commercial minus 325 mesh lead powder at various lead-to-mortar ratios and with various additives. They showed that lead loading should be maintained below 4%. However, when polyvinyl alcohol (PVA) was added, the lead was chemically stabilized, and much higher loadings could be used. Over 10% was tested with TCLP; the results were below the detection limit of 0.01 mg/l .

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