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TITLE: DECONTAMINATION OF CONCRETE SURFACES AT THE LOS ALAMOS SCIENTIFIC LABORATORY

AUTHOR(S): E(arl) James Cox, H-1
Raymond Garde, H-1

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University of California

LOS ALAMOS SCIENTIFIC LABORATORY
Post Office Box 1663 Los Alamos, New Mexico 87545
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DECONTAMINATION OF CONCRETE SURFACES AT THE LOS ALAMOS SCIENTIFIC LABORATORY

E. J. Cox, R. Garde

Health Physics Group H-1
Los Alamos Scientific Laboratory
Los Alamos New Mexico 87535

For the past two years the Los Alamos Scientific Laboratory has been engaged in decontaminating its former plutonium facility. The facility was in use for over 30 years for plutonium operations varying from dry metalurgical processes to wet (solution) recovery processes.

To date approximately 3400 square meters of floor surface have been decontaminated to permit re-use for nonplutonium work. Approximately 330 square meters of concrete surfaces required scarifying the contamination after all other attempts such as detergents and acid solutions had proven ineffective.

The uses of hand-held and floor type pneumatic scarifiers are described as well as an inexpensive but effective contamination containment chamber built at Los Alamos for use with the hand-held model.

Contamination control, waste handling, manpower requirements, and cost are documented for the techniques used at LASL.

INTRODUCTION

In early 1978 Los Alamos Scientific Laboratory (LASL) personnel were faced with the problem of decontaminating LASL's former plutonium facility, DP-West, to permit its re-use for nonplutonium work. Although the major early concerns were gloveboxes and process equipment, it was recognized that ultimately 5300 square meters of concrete slab floors would require decontamination.

Until the DP-West project began, concrete decontamination at LASL (beyond detergents and scrubbing machines) had been accomplished by scrubbing with acids, removal of contaminated paint with paint removers, and some limited scarifying with pneumatic chippers. These techniques had sufficed in the past, but DP-West presented larger areas than ever before, and quite possibly higher contamination levels than ever before. LASL decontamination personnel recognized the need for better techniques to prevent the decontamination of floors from becoming a bottleneck in meeting scheduled total building decontamination deadlines.

A review of the state-of-the-art revealed only one technique which might remove the contamination, yet salvage the floor. The technique involved the use of pneumatic scarifying tools known as scabblers, manufactured by McDonald Air Tool Corporation, South Hackensack, New Jersey. Wilbur D. Kittinger of Atomics International, Conoga Park, California, reported success with scabblers. Hand-held and floor type models were purchased, contamination containment auxiliary equipment was constructed, and experimentation began in some isolated areas.

The scabblers were found to be effective for decontaminating concrete that had several coats of paint, with contamination between the coats and sometimes in the concrete itself. Together with the established acid and paint remover operations, they have been used successfully in decontaminating approximately 3400 square meters of contaminated concrete slabs.

CONTAMINATION DETECTION TECHNIQUES

In a facility such as DP-West, with a long history of plutonium operations and known spills and releases of contaminants through the years, it is imperative that contamination both on the surface and under paint be measured.

Surface alpha contamination is measured with portable air proportional counters with a 50 cm^2 probe. The models used have been the Eberline PAC-7 and Ludlum 139, with lower detection limits of approximately 100 d/min/50 cm^2. Large areas are surveyed with wheel mounted instruments using 500 cm^2 probes such as the Eberline Model FM-30, with approximately the same detection limit.

The contamination under painted surfaces is measured by a LASL developed phoswich (phosphor sandwich) detector[1] which consists of a NaI crystal backed by a CsI crystal, and measures plutonium L X-Rays. The detector, electronics, and scaler are housed individually as shown in use in Figure 1. The electronics include an aural popper used when background noise levels permit.

The phoswich is very sensitive to scatter radiation, hence, plutonium process equipment and high contamination levels must be eliminated or reduced prior to its use. However, in the latter stages of a decontamination project, it is extremely useful as an indicator of how much contamination is under paint, in a wall, etc. Although confirmatory data are still being collected it appears that, in the field, the detector is capable of measuring 200 d/m/cm^2 through as many as five coats of paint.

SELECTION OF METHOD

The three basic techniques used at LASL are application of paint remover, acid solutions, and pneumatic scarifying. Each can be the most desirable method in one case, yet be the least desirable in another. The considerations and the pertinent questions involved in the proper selection are the following:

o GOALS	Is complete decontamination required, or merely decontamination to a level consistent with the surrounding surfaces? Is it important to minimize damage to the surface, because the surface must be restored?
o CONCRETE FINISH	Is the concrete painted? Was the floor painted prior to its first contamination? In short, will removal of the paint complete the job?
o SIZE OF AREA	Is the area large enough to justify the required preparation time? Can the job be done more quickly and effectively by a normally slower technique requiring less preparation time?
o CONTAMINATION	What are the contaminants? What is the contamination level? Is the contamination on the surface or under layers of paint?
o LOCATION	Is the area to be decontaminated near necessary utilities, i.e., power, water? Is the area congested, precluding the use of large equipment? What is going on in vicinity of operation, i.e., will noise or traffic control be problems?
o WASTES	Is a particular technique going to result in fewer waste handling problems?

The answers to the questions above, and the advantages and disadvantages of the techniques described in Table 1 are used in selecting the technique or combination of techniques to be used.

EQUIPMENT AND TECHNIQUES

PAINT REMOVAL

Equipment and Techniques

A commercially available paint remover, Turco Type 5351, is applied with a brush and allowed to set until a visible reaction takes place (about

15-20 minutes). The surface is then scraped with a hand held scraper or steel wool. Sometimes the surface is scratched to permit the remover to seep under paint. Two applications are usually required due to the roughness and porosity of the concrete surface. The applications are followed by a water and detergent scrubbing to remove the paint remover.

TABLE 1. Comparison of LASL's Concrete Decontamination Techniques

Technique	Advantages	Disadvantages
PAINT REMOVER:	Requires less equipment and people.	Slowest of the methods.
	Requires less preparation time.	If contamination is in concrete, other techniques are required.
	Does the least damage to floor surfaces; generates the least waste.	
ACIDS:	Improve detergent action when used with mechanical scrubbers.	Can carry contamination deeper into concrete.
	Very effective with loosely bound surface contamination.	Slow; may require several attempts.
	Cleans embedded metal items also.	Generates liquid wastes from rinsing operations.
		May require specialized ventilation systems.
SCARIFYING:	Fastest method for removing deeply embedded contamination.	Requires the most people, equipment, and utilities.
		Noisy and tiresome.
		Damages surfaces.
		Creates large volumes of water.

This method is useful for small areas (< 1 m^2) when the contamination is on the surface or between layers of paint but not in the concrete itself. Normal room ventilation is usually adequate; no special respirator equipment is required to handle the paint remover.

Preventing Spread of Contamination

The immediate surrounding area is covered with plastic to prevent spreading the contamination. Scrapings are damp and sticky, so airborne contamination is not a problem. The contaminants are controlled by packaging wastes and changing the brushes and scrapers frequently.

Waste Handling Methods

The volume of waste generated by paint removal operations (including contaminated applicators, scrapers, etc.), is less than .05 m^3 of waste per m^2 of surface. The wastes are placed in double plastic bags, sealed in cardboard boxes, and the plutonium content is measured to determine if the waste package is retrievable (> 10 nCi ^{239}Pu or 100 nCi ^{238}Pu per gram of waste). The measurement is obtained by a Multiple Energy Gamma Assay System (MEGAS)[(2)] that automatically measures the plutonium (transuranics) content, weighs the waste package, and computes transuranics concentration in nCi/g. Nonretrievable wastes are buried in shallow ($\approx$ 10 m) trenches at the LASL Solid Waste Disposal/Storage Site. Retrievable wastes are stored in 20-year storage containers at the same site.[(3)]

Rate of Performance

Typically a small (< 1 m^2) contaminated area where two coats of paint must be removed can be decontaminated at a rate of 0.3 m^2/hour by two people. This includes changing clothes preparing the area, applying the paint remover, removing the paint remover, washing the area and packaging the waste; but does not include time for transportation. Transportation time varies greatly at LASL because of the large geographical distances between facilities.

ACIDS

Acid solutions are used to remove contamination embedded near the surface of the paint or in concrete. Contaminated concrete is usually found in facilities where the concrete floor was not painted prior to using the facility.

Equipment and Techniques

The acids generally used are HNO_3 and $HC\ell$, in concentrations ranging from a 10-20% by volume used in scrubbing machines, to concentrated acids used to decontaminate small areas ($< 0.1\ m^2$).

The acid solutions are poured or sprayed on the contaminated area, allowed to set for a few minutes then wiped up with rags. The area is rinsed with water; the steps are repeated if necessary. A vacuum cleaner is used to collect the dilute solutions from the scrubbing machine and rinsing operations.

Preventing Spread of Contamination

The spread of contamination is prevented by isolating the area, packaging the waste frequently, and keeping the equipment as free of contamination as possible.

Waste Handling Methods

The use of acid solutions generates both liquid and solid wastes. Water is used in diluting the acids, washing the area and rinsing the rags. Liquid wastes are treated as part of the large volumes of low-level wastes handled at LASL's two liquid waste treatment facilities.[4] The wastes are transported to the treatment facilities by pipe line or by tank trailer. Solid wastes are disposed of at the on-site LASL solid Radioactive Waste Disposal/Storage Site.

Rate of Performance

The use of dilute acids in scrubbing operations increases the decontamination time required because of acid handling problems, the manual spreading of powdered detergents on the floor, and the additional rinse water required for the floor and the scrubbing machines.

A painted floor area that is relatively free of obstructions can be scrubbed at a rate of approximately 25 m^2/hr by two people. Unpainted surfaces may require two rinses when the concrete surface is rough.

The limited use of concentrated acids at LASL precludes good rate-of performance data. Two people are required for safety; the area may be nothing more than a few square centimeters, and it may be several miles from the technicians' work site. In general, the requirements for handling the wastes and the time required result in using this technique when there is no other option.

SCARIFYING

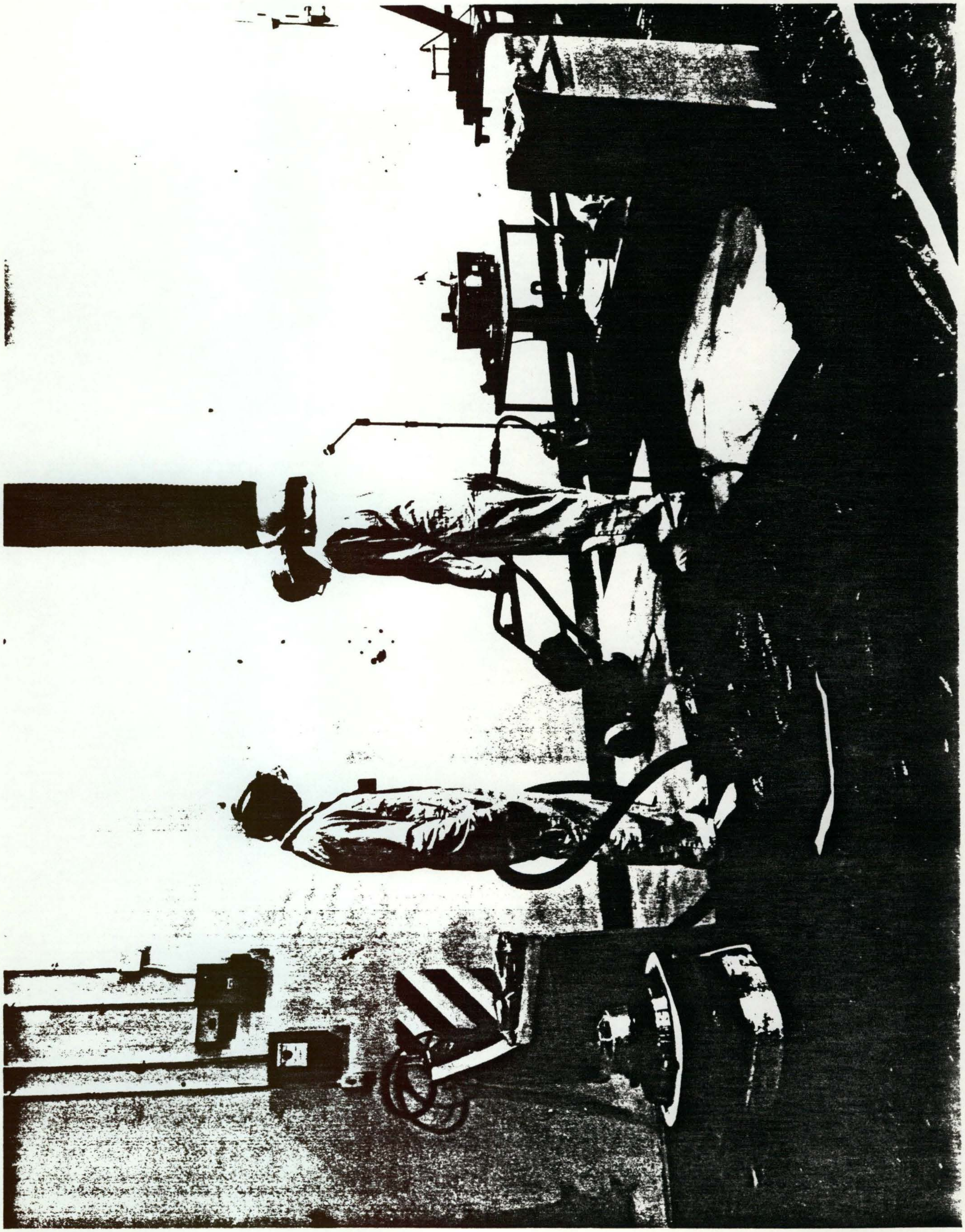
Equipment and Techniques

Pneumatic scarifying is used at LASL when the contamination is in the concrete. As mentioned in the introduction, most of the scarifying is done by a hand held or floor model scabbler shown in Figures 2 and 3. There are a few instances however, when different pneumatic chisels, hammers, or needle guns need to be used for a hard-to-reach spot.

The hand held model used at LASL is a McDonald Model HS single head unit. When it was first purchased and little was known about its operation, airborne contamination was a prime concern. Therefore, a confinement chamber was constructed from an old glovebox. The chamber, with its air and vacuum supply lines is shown in Figure 2. The scabbler is operated at 20 cfm of air at 80 psi pressure. It has been used to remove contamination at levels up to 2×10^8 d/min/50 cm^2. The chamber allows for interchanging to the less frequently used chippers, needle guns, etc.

The floor model used at LASL is the McDonald Model L-7. It utilizes seven heads similar to the one on the hand held unit and requires 100 cfm of air at a pressure of 100 psi. Its limitation is that it can only be used on very wet floors. Both units use replaceable tungsten carbide bits which have a working life of approximately 80 hours.

The use of the hand held scabbler requires two people, one doing the scabbling and one in a supporting role, i.e. surveying, monitoring the



room air, assisting with the waste handling, etc. The two people need to alternate operating the scabbler to minimize fatigue. Experience indicates the confinement chamber is not necessary if surfaces are kept wet.

The floor model is used with a team of three people. One person runs the scabbler, one keeps the area wet and provides the necessary miscellaneous support, and one vacuums up the contaminated concrete as it is loosened.

With either scabbler, approximately 1/8 inch of surface is removed per pass. In general, unless contamination was embedded deeply as a result of a crack or opening in the concrete two or three passes complete the job. There are, however, cases where concrete must be scabbled to a depth of an inch or so. These cases have usually required the use of the hand-held model because the surface areas have been small.

Preventing Spread of Contamination

The spread of contamination is prevented by operating the scabbler under wet conditions, and by immediately vacuuming up water and concrete. Paint is sometimes employed prior to the operation to indicate where the scarifying needs to be done. The paint also assists in containing the contamination.

Waste Handling Methods

Of the three general techiques employed at LASL, the use of the scabbler produces the largest volume of waste. Experience at DP-West indicates wastes are generated at rates of 4 gallons of water and .04 pounds of cement/paint sludge per m^2 of concrete floor. Since the DP waste decontamination operation is only a few hundred meters from a waste treatment facility, waste handling has not been a problem. The liquid waste is transported in a tank-trailer; the cement sludge is transported in 200-liter drums.

Rate of Performance

The scabbling operations range in speed from 0.1 m^2/hr with the hand-held unit and a crew of two people, to 1 m^2/hr with the floor model scabbler and three people. Preparation takes longer compared to other methods because of equipment requirements.

PERSONNEL TRAINING

All three methods in use at LASL are performed by technicians versed in decontamination operations of all types. They are trained in the use of chemicals such as acids, bases, and solvents. They are knowledgeable in the use of the radiation monitoring instruments necessary to perform their jobs, and trained in the use of protective clothing and respiratory protection equipment. The step-by-step training is acquired through following established Standard Operating Procedures and by assisting experienced personnel. For safety reasons, no technician is allowed to work alone.

COSTS

In order to summarize LASL's experiences in the economics of decontaminating concrete surfaces, three hypothetical decontamination requirements are postulated. Areas of 1 m^2, 10 m^2, and 100 m^2 with different conditions and requirements are addressed in Table 2. The table shows the process selection considerations and LASL costs in time and dollars. The transportation time is omitted since LASL work areas are so widely dispersed. Including transportation time and costs would make cost comparisons with non-LASL operations very difficult. For a small job at LASL, the transportation costs may be as high as the cost of performing the decontamination. Table 3 lists equipment and services considered in the sample tasks. A rate of $22/hr, including overhead, is used to estimate project costs.

SUMMARY

The three simple decontamination techniques have been adequate for the DP-West project. The reasons have been:

- o the decontamination rate has been adequate to fit into the overall building decontamination schedule;
- o the spreading of contamination has been prevented;
- o with few exceptions, all contaminated concrete surfaces encountered have been floors;
- o the techniques have been effective, no contamination has been detected during refurbishing operations in decontaminated areas;
- o the wastes created are compatible to and easily managed by existing LASL waste treatment capabilities.

Although LASL's experiences are primarily with alpha contamination, the techniques can be expected to work with other contaminants as well.

TABLE 2. Decontamination cost comparisons for three different size areas under various conditions.

Contamination Levels[a]	Surface Condition	Method	Decon Man-Hours, Area in m^2: 1	10	100	Total Man-Hours, Area in m^2: 1	10	100	Total Cost $[b], Area in m^2: 1	10	100	Average Cost $/$m^2$, Area in m^2: 1	10	100
Low α; Low L X-Rays	Painted	Acid Scrubbing	1	2	8	4	6	15	90	135	330	90	13	3
	Unpainted	Acid Scrubbing	2	3	10	5	7	17	110	155	375	110	16	4
High L X-Rays; Low or High α	Painted	Paint Removal	4	16	160	7	24	176	150	530	3900	150	53	39
		Scabbling	10	30	300	16	54	336	350	1200	7400	350	120	74
	Unpainted	Scabbling	10	30	300	16	54	336	350	1200	7400	350	120	74
High α; Low L X-Rays	Painted	Paint Removal	4	16	·160	7	24	176	150	530	3900	150	53	39
		Acid Scrubbing	2	3	8	6	8	17	130	175	375	130	18	4
	Unpainted	Acid Scrubbing	2	4	10	6	9	19	130	200	420	130	20	4

(a) α measurement used to measure surface contamination, L X-ray measurements used to measure contamination covered with paint (see text for instrumentation) levels, costs, etc.

(b) Costs are based on a $22/hr personnel cost which includes overhead.

TABLE 3. Equipment and Services Required for Decontamination of Concrete Surfaces.

EQUIPMENT:

McDonald scabblers, wall and floor models
Compressor, air line hoses and connectors
Vacuum cleaners, dry (filtered) and wet
Assorted vacuum hoses and attachments
Scrubbing machines, brushes
Tank trailer, pump and liquid hoses for waste disposal
Waste containers
Waste transport vehicle
Acids, paint remover, detergents, and paint
Cardboard boxes, plastic bags, plastic sheeting, scrapers
Rags, brushes pails, tape, and miscellaneous hand tools
Assortment of pneumatic hand tools
Protective clothing respiratory, and ear protection equipment
Portable radiation detection instruments
Eyewash equipment

SERVICES:

Electrical power
Water
A crew of trained radiation workers

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FIGURE CAPTIONS

FIGURE 1. Phoswich detector in use.

FIGURE 2. Use of hand-held scabbler in a confinement chamber.

FIGURE 3. A seven-head floor scabbler, in area prepared for decontamination.