DEMONSTRATION EXPERIENCE WITH AN ABRASIVE BLASTING TECHNIQUE FOR DECONTAMINATING CONCRETE PADS[*]

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ABSTRACT

A demonstration was performed for decontaminating a radioactively contaminated concrete pad with a portable abrasive blasting system. The system utilizes a rotating blast wheel that scours the concrete surface with metal abrasive. The metal abrasive, pulverized concrete dust, and contaminants rebound into a separator chamber. The reusable metal abrasive is recycled, and the pulverized media are removed to an integral dust collection system. The exhaust is HEPA filtered to minimize release of airborne contaminants. The system was set up to remove 1.6 mm of concrete layer per pass. Decontamination factor of about 0.5 was achieved with the first pass; two subsequent passes achieved decontamination factors of 0.3 and 0.2, respectively.

However, the technique had limited success in reducing contamination around the cracks and seams in the concrete where the higher activity levels of contamination were detected during the radiological survey before the cleanup. The technique can be successful and cost-effective in decontaminating large areas of low contamination; however, careful characterization and planning are necessary.

SITE BACKGROUND

The Elza Gate site covers an area of about 8 ha (20
res) and is located in the southeastern part of the city of
ak Ridge, Tennessee, near the intersection of Melton
ake Drive and Oak Ridge Turnpike (Fig. 1). The site was
ed by the Manhattan Engineer District (MED) in the
rly 1940s as a storage area for uranium ore and ore-pro-
ssing residues. Five warehouses (with concrete pad
oors) were used for storing materials. In 1946, the Atomic
nergy Commission (AEC) assumed ownership of the site
d used it as a storage area for the Y-12 plant. The AEC
ed the site until 1972, at which time it was vacated, and,
bsequent to a decontamination performed under the
idelines and criteria current at that time, the title to the
operty was transferred to the city of Oak Ridge. The
operty was then sold to Jet Aire, Inc., in 1972 and used
r operation of a metal plating facility. The ownership of
e site passed on to Meco, a development company, in
nuary 1988, and it is currently being developed for use as
industrial park. None of the original structures remain,
t the concrete pads upon which the warehouses were built
e still in place. There is one building on site that was
ected on one of the existing concrete pads (Fig. 2). The
ilding is leased by Electro-Panel and is used for fabricat-
g metal containers. The original concrete pad (Pad 1) that forms a part of the floor of this building was decontaminated as a part of the demonstration of the abrasive blasting technique.

RADIOLOGICAL CONDITIONS

Oak Ridge Associated Universities (ORAU) conducted a survey of the site in 1987 at the request of the Tennessee Department of Health and Environment because of the possibility of contamination from the metal plating facility(1). A radiological survey of the site was conducted in October 1988 by the Oak Ridge National Laboratory (ORNL)(2). Both surveys confirmed the presence of elevated levels of naturally occurring radionuclides (mainly from U-238 decay series) in soils in the northern portion of the site and on the existing concrete pads. The site was authorized for inclusion in the Formerly Utilized Sites Remedial Action Program (FUSRAP) in November 1988(3). Bechtel National, Inc., (BNI) is currently in the process of characterizing the site.

The five concrete pads total about 7,800 m^2 in area and are primarily contaminated with Th-230, Ra-226, U-238, and Th-232. Rings of rust-colored stains crusted over with a yellow residue are visible in scattered areas on the pads where 55-gallon metal drums had apparently been stored in the past. Pad 1 measures about 1,000 m^2 in area and forms a part of the floor of the only building that is currently

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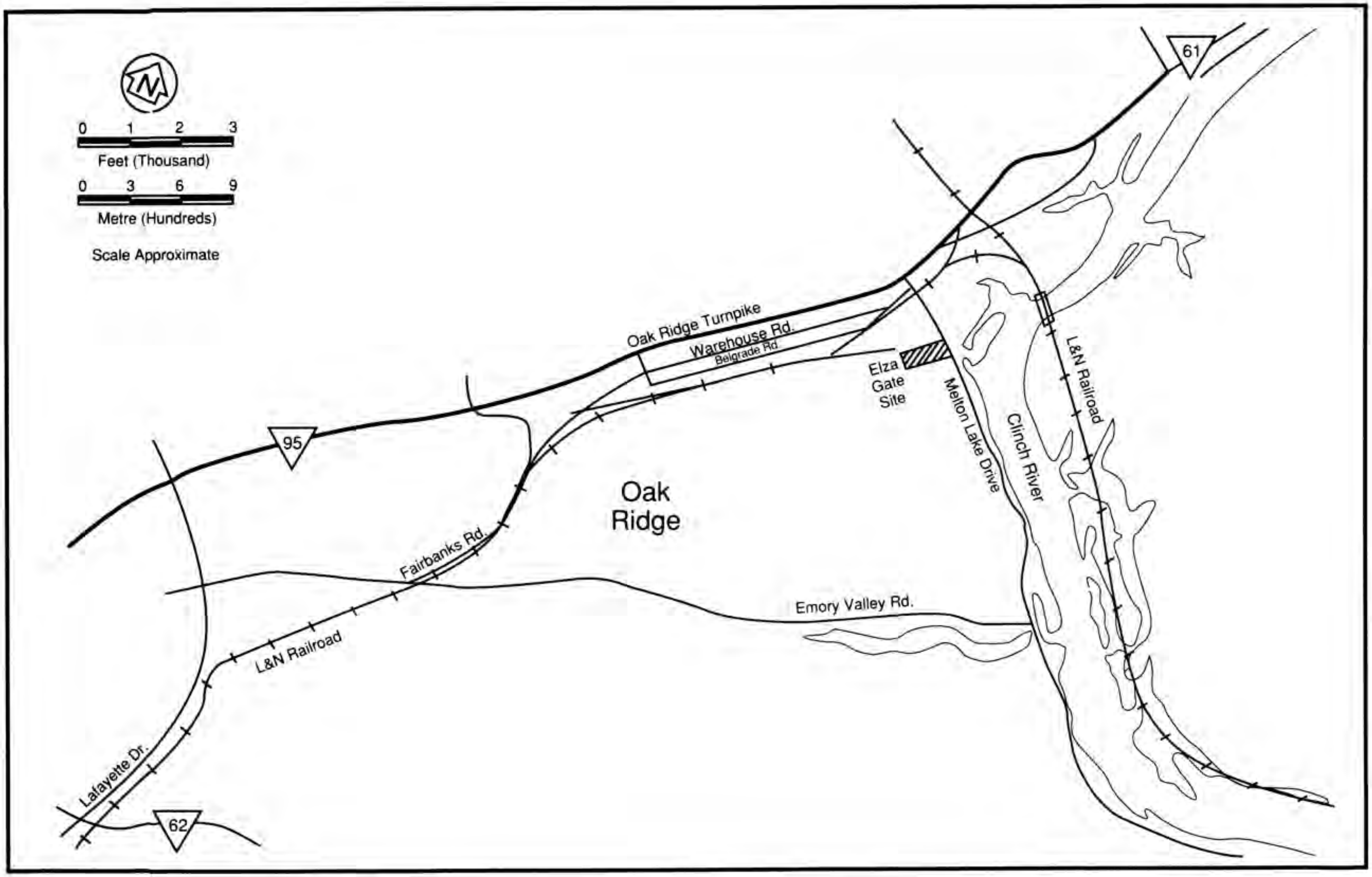

Fig. 1. Location of the Elza Gate Site.

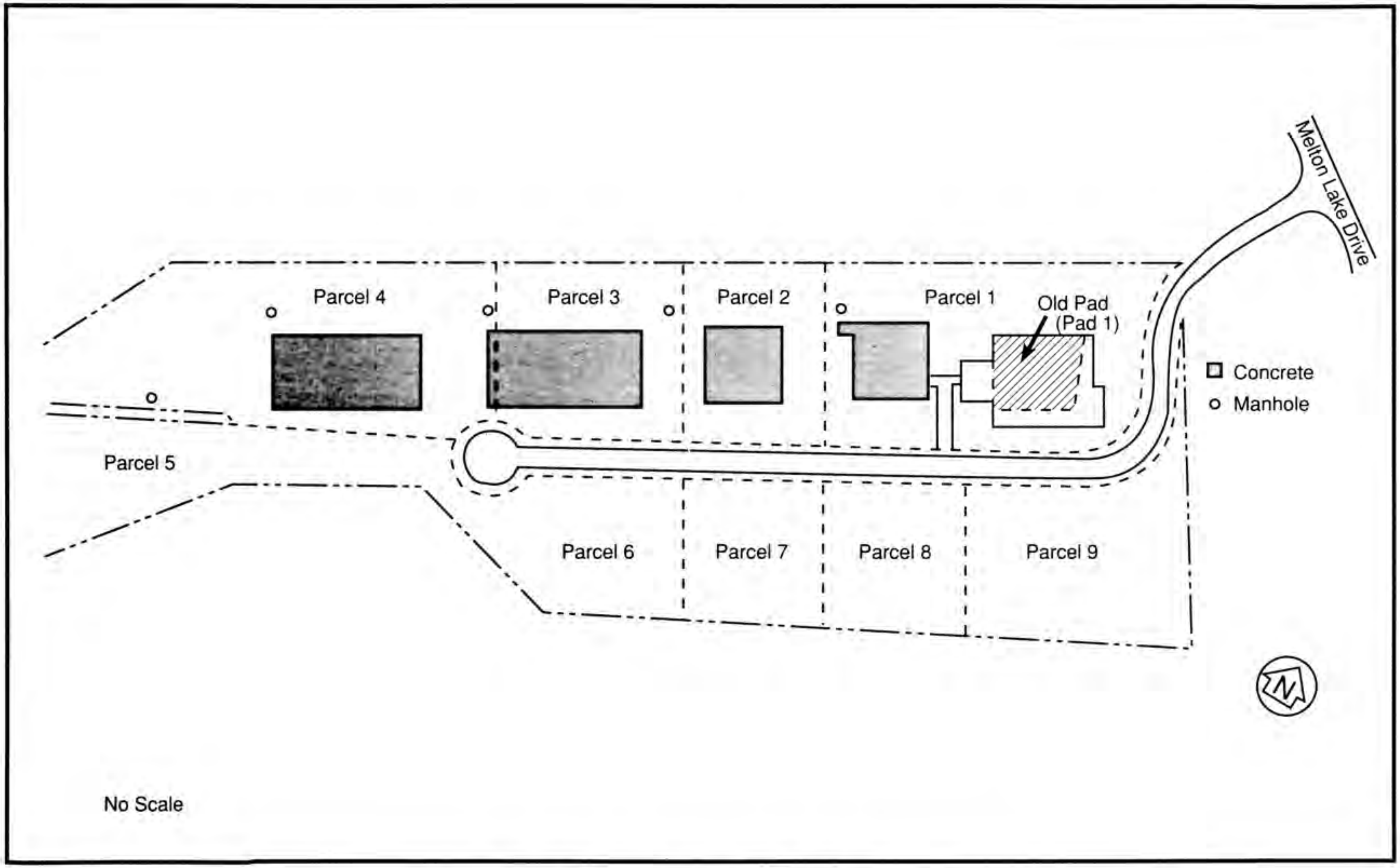

Fig. 2. Plan View of the Elza Gate Site.

present at the site. Gamma exposure rates measured at 1 m ranged from 5 to 40 μR/h with an average of 14 μR/h; at surface, the measurements ranged from 4 to 200 μR/h with an average of 30 μR/h. The highest measurements were found at structural cracks and seams in the old concrete pad. Some measurements exceeded the DOE guideline of 20 μR/h above background for indoor gamma exposure rates. Alpha activity levels ranged from 14 to 17,000 dpm/100 cm^2. While the average of all measurements was 2,700 dpm/100 cm^2, some grid blocks averaged over 6,000 dpm/100 cm^2, exceeding the DOE guidelines for uranium alpha-emitters. The beta-gamma dose rates ranged from background to 20 mrad/h with maximum readings on cracks and seams. However, analyses of smear samples showed that the contamination is not readily transferable. Since the areas of elevated contamination are limited to isolated spots at the surface associated with cracks and seams in the concrete pad, it is highly unlikely that any individual working in the building would receive a significant radiation exposure.

On average, the radiological contamination of the concrete pads is to a depth of about 0.5 cm. Thus, abrasive blasting techniques were considered suitable and cost-effective as a technology for decontaminating the pads. In the summer of 1989, a demonstration of the technique was conducted on Pad 1 to evaluate its effectiveness and its suitability to the cleanup of all pads at the site.

SYSTEM DESCRIPTION

A portable blast cleaning system, normally used to prepare concrete surfaces for application of coatings, was field tested to determine its effectiveness in removing contamination from horizontal poured concrete surfaces. A sketch of the equipment configuration is shown in Fig. 3.

The portable blast cleaning system used* was a downblast machine for closed-cycle abrasive cleaning of horizontal surfaces that incorporates a high-performance, airless centrifugal wheel to propel blast media in a controlled direction and pattern. Metal abrasive thrown by the rapidly rotating blast wheel (3,600 rpm, 30 hp) scours the concrete surface then rebounds, along with removed contaminants, into a rebound chamber which directs the abrasives and dust into an airwash dust extractor which removes dust, scale, and other contaminants from the abrasive so that predominantly good quality steel abrasive is delivered by gravity to a storage hopper for reuse by the blast wheel. The metal abrasive used was a high-quality tempered martensitic steel. The machine itself has an empty weight of 717 kg (1,580 lbs) and is propelled by an electric variable-speed, 3/4-hp traction drive system. Pulverized abrasive, dust, and contaminants are removed by an attached dust collector, and the reusable shot is automatically returned for reuse.

The blast unit is connected to a dust collector by a 22.8 m (75-ft) length of 15.2 cm (6-in.) diameter flexible hose. The self-contained dust collector, empty weight 544 kg (1,200 lbs), is mounted on a hand-towed mobile chassis. The vacuum exhaust system uses a blower powered by a 7.5-hp, direct-drive motor to develop 401 L/S (850 CFM) air flow at the collector's intake nozzle. The air flow developed by the blower cools the blast machine components, sweeps residual abrasive from the blast surface, separates dust and scale from the supply of usable abrasive, and conveys dust and scale to the dust collector. The central part of the dust collector is a filter chamber. Dust-laden air ducted from the blast unit flows through an array of eight vertically-mounted filter cartridges in the filter chamber. Dust is captured by the surfaces of the cartridges, allowing only filtered air to pass. The filters are rated at 99.4% effective for all airborne particles 3.0 microns and larger. The filtered air is moved by an exhauster to the open atmosphere. The dust captured by the cartridges is periodically removed by rapidly pulsing the cartridges with a pulse of compressed air. The dust drops from the cartridges into a disposal bin mounted below the filter chamber.

For the demonstration, the system was modified to reduce the potential exposure of individuals to airborne particulate matter. A portable air handling unit containing a High Efficiency Particulate Air (HEPA) filter, which removes 99.97% of all airborne particles 0.3 microns and larger, was attached to the exhaust of the dust collector. The modification permitted operation of the system without requiring the use of respiratory equipment by the system operators and permitted operation of the system in areas occupied by the facility personnel.

The portable blast cleaning system can remove surface layers up to about 6 mm (1/4 in.) in a single pass from the concrete pads. During this demonstration, it was set up to remove about 1.6 mm (1/16 in.) of concrete per pass, and production rates approached 93 m^2/h (1,000 ft^2/h). However, the system was ineffective where surface discontinuities interfered with the rebounding of the blast media. Cracks, expansion joints, and uneven floor surfaces are examples of such discontinuities. Cracks and uneven surfaces changed the direction of the shot's rebound, preventing its recovery and causing the shot to become deposited on the surface being blasted. The shot remaining on the surface would absorb sufficient kinetic energy from the following shot to further exacerbate the problem. Loose

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* The portable blast cleaning system used was a Blastrac Model 1-20D from the Wheelabrator Corporation, Shenandoah, GA.

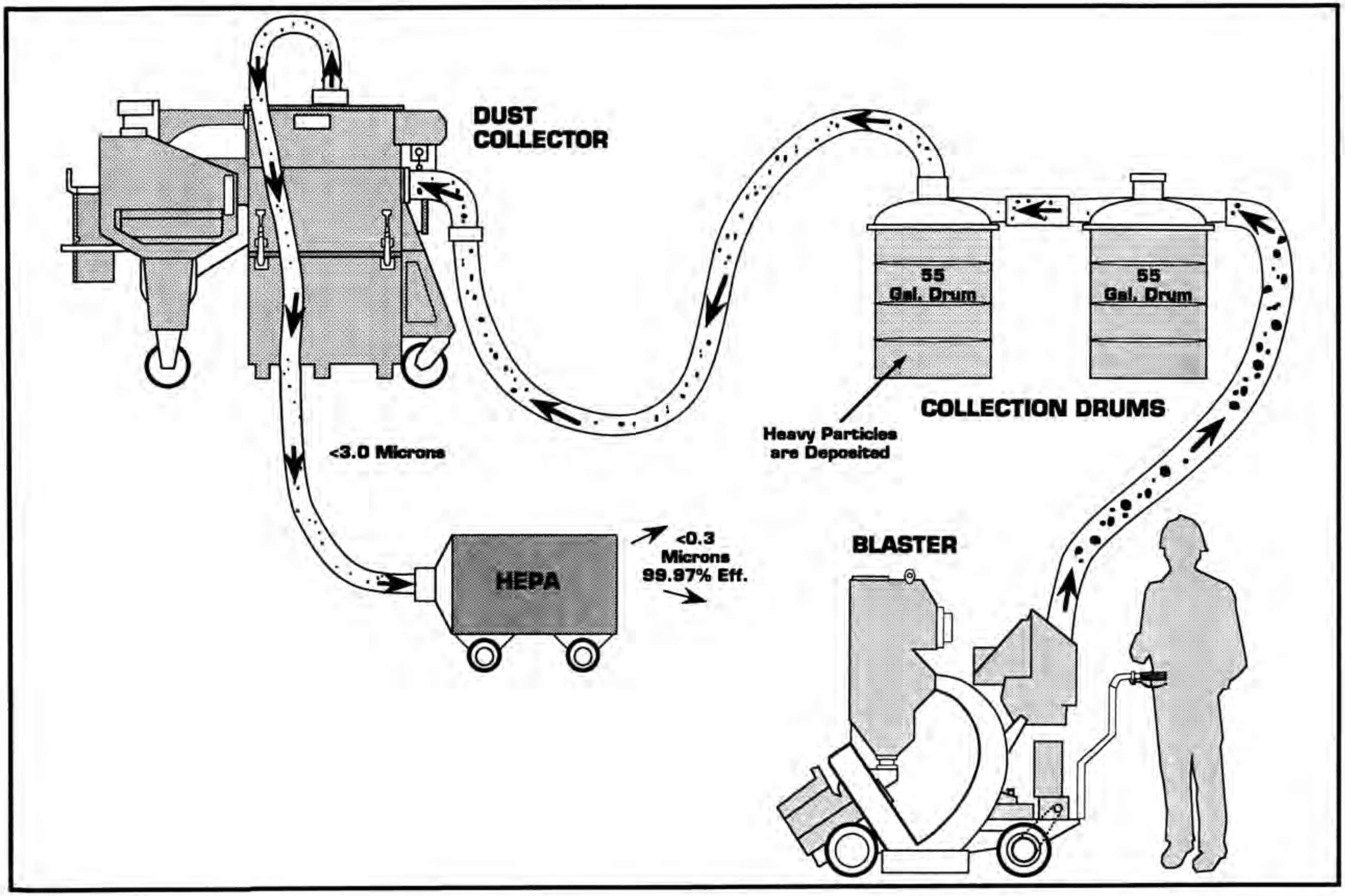

Fig. 3. Shot blast cleaning system.

surface contamination, such as dirt or spalled concrete, would also absorb kinetic energy from the shot, causing it to improperly rebound. Therefore, the surface to be blasted required sweeping and/or vacuuming prior to blasting.

During the demonstration, approximately 1,000 m^2 of concrete pad had from 0.8 to 6 mm (1/32 to 1/4 in.) of its surface removed. The removal depth of the system is adjusted by varying the travel speed of the blast unit. A decrease in speed lengthens the residence time over an area, correspondingly increasing the depth of removal. Minor surficial cracking was also removed by the blast system. However, an extensive expansion joint system in the concrete pad was not decontaminated. Nor was deep contamination (greater than 6 mm) removed. The unit requires a 0.3 m (12-in.) clearance in areas adjoining vertical surfaces (walls, stanchions, and structural steel members). Such areas will require decontamination by other surface removal methods.

DECONTAMINATION RESULTS

A radiological characterization survey was performed by TMA/Eberline on five concrete pads at the Elza Gate site to assess the alpha and beta-gamma contamination levels. This survey consisted of direct and transferable measurements. A grid was established for each pad to aid in recording scan and direct measurement data. Pad 1 was selected for the decontamination demonstration due to more extensive contamination present and possible tenant occupancy. Also, this pad was the only one under roof.

The radiological characterization survey consisted of making independent measurements for alpha and beta-gamma radiation using an alpha scintillation detector and a thin window beta-gamma detector with shielding provided to prohibit any alpha response. This survey revealed that direct surface contamination activity for Pad 1 ranged from minimum detectable activity (MDA) (14 dpm/100 cm^2) to 17,000 dpm/100 cm^2 alpha and 600 dpm/100 cm^2 (MDA) to 98,000 dpm/100 cm^2 beta-gamma, with an average of 2,700 dpm/100 cm^2 and 16,500 dpm/100 cm^2, respectively. Transferable surface contamination activity ranged from 2 dpm/100 cm^2 (MDA) to 25 dpm/100 cm^2 alpha and 65 dpm/100 cm^2 (MDA) to 230 dpm/100 cm^2 beta-gamma, with an average of 5 dpm/100 cm^2 and 125 dpm/100 cm^2, respectively.

Air sampling measurements were performed at floor level on the machine, and HEPA filter exhaust, around the general controlled area, and on personnel to establish the potential airborne concentrations of radionuclides released during the decontamination procedure. These air samples were analyzed for gross alpha activity, and none was detected above the MDA of about 5 x 10^{-14})Ci/mL.

The portable abrasive blasting system was set up to remove approximately 1.6 mm of concrete per pass. Upon removal of the top layer, direct alpha and beta-gamma measurements were conducted to evaluate the contamination reduction (see Table I). These measurements showed a decontamination factor (ratio of contamination removed during the pass to the contamination present before the pass) of approximately 0.5. However, the beta-gamma measurements were still above the DOE surface contamination guidelines of 5,000 dpm/100 cm^2 for U-238. Two subsequent passes achieved decontamination factors of 0.3 and 0.2, respectively. Contamination around expansion joints and areas of dense aggregate material in the concrete were not reduced as effectively. The expansion joints consisted of a tar-like material which traps the contamination. The sides of the slab (between expansion joints) remained elevated due to lack of contact with the blasting beads. The dense aggregate areas required additional decontamination to depths of 8 mm, while the average contamination depth was 5 mm.

CONCLUSIONS

The portable abrasive blasting technique used at the Elza Gate site was effective in reducing the surface contamination levels on a concrete pad. However, rough, uneven surfaces resulted due to various contamination depths in the concrete and the density of aggregate fill material which was somewhat impervious to the abrasive. A resurfacing of the concrete is necessary to restore it to the original condition. Expansion joints and cracks were not effectively decontaminated, which require additional efforts to remediate. The technique can be successful in decontaminating large areas at specific sites where low level contamination exists. Careful characterization, planning, and design criteria consider-

TABLE I

Summary of Radiological Conditions Before and After Decontamination Efforts

Before Decontamination Average dpm/100 cm^2		First Pass Average dpm/100 cm^2		Second Pass Average dpm/100 cm^2		Third Pass Average dpm/100 cm^2	
Alpha	Beta-Gamma	Alpha	Beta-Gamma	Alpha	Beta-Gamma	Alpha	Beta-Gamma
2,700	16,600	1,350	8,300	950	5,800	750	4,600

ations are necessary for this technique to be cost-effective in reaching desired decontamination objectives.

REFERENCES

1. R.L. EGLI (DOE-OR), "Sampling Data for Land Parcel 228," letter dated April 25, 1988, to K. Cole (Oak Ridge, Tenn.). [Copy available from U.S. Department of Energy, Oak Ridge Operations, Technical Services Division, Oak Ridge, Tennessee.

2. W.D. COTTRELL, J.L. QUILLEN, and R.F. CARRIER, "Preliminary Site Survey Report for the Former Elza Gate Warehouse Area, Oak Ridge, Tennessee," Draft Report ORNL/RASA-89/A, Oak Ridge National Laboratory (June 1989).

3. J.J. FIORE (DOE-NE), "Authorization for Remedial Action at the Melton Lake Industrial Park (Former Elza Gate Area Warehouses), Oak Ridge, Tennessee," memorandum dated November 30, 1988, to P. Gross (DOE-OR). [Copy available from U.S. Department of Energy, Oak Ridge Operations, Technical Services Division, Oak Ridge, Tennessee.