Asbestos Release during Building Demolition Activities

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16. ABSTRACT

The Risk Reduction Engineering Laboratory has monitored block-wide building demolition and debris disposal activities at Santa Cruz and Watsonsville, California following the earthquake, an implosion demolition of a 26-story building in Cincinnati, Ohio, and the demolition of two school buildings in Fairbanks, Alaska to evaluate if the demolition activities and their associated dust control practices were able to prevent downwind elevations of asbestos concentrations.

The analyses of the air samples were performed using the Transmission Electron Microscope for ambient air levels. Personnel monitoring at the Santa Cruz landfill and the Fairbanks landfill during disposal activities were analyzed by both TEM and phase contrast microscopy.

The paper documents the conditions of the buildings, demolition practices, dust control practices, and up and downwind asbestos concentrations during demolition.

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Asbestos Release During Building Demolition Activities

Roger C. Wilmoth[A], Kim A. Brackett[B], Patrick J. Clark[A], Bruce A. Hollett[A], Thomas J. Powers[A], and James R. Millette[C]

The U.S. Environmental Protection Agency's (EPA) Risk Reduction Engineering Laboratory (RREL) monitored block-wide building demolition and debris disposal activities at Santa Cruz and Watsonsville, California following the 1989 earthquake; an implosion demolition of a 26-story building in Cincinnati, Ohio; the demolition of eight wooden barracks at Fort Bliss, Texas; and the demolition of two school buildings in Fairbanks, Alaska to evaluate if the demolition activities and their associated dust control practices were able to prevent downwind elevations of asbestos concentrations and to measure the concomitant worker exposure levels.

For the study detailed here, ambient air samples for transmission electron microscopy (TEM) were collected on short-cowled three-piece sampling cassettes containing a 0.45 μm pore mixed cellulose ester (MCE) membrane filter backed by a 5 μm pore MCE diffusing filter and support pad. Analysis of the ambient air samples was performed in the RREL Electron Microscopy Facility using the TEM following all the standard QA/QC procedures and methodology required by the Asbestos Hazardous Emergency Response Act[1] (AHERA) protocol. Personnel monitoring at the Santa Cruz landfill and the Fairbanks landfill during disposal were collected and analyzed in accordance with the National Institute for Occupational Safety and Health (NIOSH) 7400 phase contrast microscopy (PCM) protocol[2] and by TEM according to a modified AHERA protocol, where all length and width measurements are recorded. Sample volumes during these investigations varied according to the duration of the particular task and ranged from about 130 liters to 545 liters, yielding limits of detection of about 0.01 fibers per cubic centimeter (f/cc) maximum to 0.003 f/cc minimum. Personnel monitoring at the Fort Bliss site was by PCM alone. Flow rates for personal samples typically were between 1.5 to 2 liters per minute. For statistical purposes, TEM samples in which no asbestos structures were counted were reported as zero structures per cubic centimeter (s/cc).

California Earthquake

After the 1989 California earthquake along the San Andreas fault, damaged buildings were condemned and rapidly demolished. The Monterey Bay Unified Air Pollution Control District and EPA Region IX asked RREL to evaluate the effectiveness of emission control practices used during demolition in preventing significant airborne asbestos release in the communities involved. RREL monitored two separate demolition activities, one in the Pacific Garden Mall in Santa Cruz and one in downtown Watsonsville. In both locations, building construction was similar, being mostly two-story brick buildings with common walls to adjacent buildings. The existence of asbestos in the structures could not be confirmed, because access to the interior of the buildings for observations and bulk sampling was prohibited for safety reasons. Since asbestos existed in similar nearby undamaged buildings, it was presumed to exist in the demolition areas as well. Typical asbestos-containing materials (ACM) in adjacent buildings consisted of vinyl asbestos tile and thermal system insulation on pipes and boilers. Control practices consisted of spraying the demolition site with water from fire hoses while demolition bulldozers, endloaders, and trucks were operating. In Santa Cruz (Table I), the demolition activity released minimal asbestos. In Watsonsville, higher levels (Table I) measured downwind of the demolition were statistically significant ($p = 0.002$) and were probably caused by the collapse of a three-story building during the monitoring period.

At Santa Cruz, the demolition debris

Sampling Site	Location	Date Sampled	Number of Samples	Mean Air Concentration Volume (L)	s/cc* (Mean)
Pacific Garden Mall, Santa Cruz	Background	11/03/89	9	1379	0.005
	Downwind	11/03/89	10	1527	0.003
	Background	11/04/89	10	1029	0.006
	Downwind	11/04/89	10	1023	0.008
	Background	11/06/89	10	895	0.008
	Downwind	11/06/89	10	1030	0.004
Municipal Landfill, Santa Cruz	Background	11/03/89	4	975	0.006
	Downwind	11/03/89	5	1308	0.005
	Bulldozer Cab	11/04/89	6	210	0.009
	Operator	11/04/89	2	176	0.060
Watsonville	Background	11/07/89	4	3111	0.006
	Downwind	11/07/89	5	804	0.051

Table I— Asbestos Release During Demolition and Disposal, Santa Cruz and Watsonville, California, 1989

*s/cc = Structures per cubic centimeter All means are arithmetic.

was taken to the local municipal landfill, causing interest in the potential for worker exposure. At the request of the Monterey Bay Unified Air Pollution Control District, two days of activity at the dump were monitored, concurrent with the sampling of the demolition. Area samples were taken on the first day (for TEM analyses) and personal monitoring samples (for both TEM and PCM analyses) were taken on the second day. No significant increase was seen ($p = 0.8254$) when the upwind and downwind asbestos levels were compared using TEM analysis; however, TEM analysis of personal samples taken on the bulldozer operator revealed elevated levels (Table I). The PCM counts on these samples averaged 0.32 f/cc. The high PCM counts prompted an inspection of those filters by TEM at low magnification to determine if the fibers seen by PCM were asbestos — none were.

The size distribution of the structures counted by TEM for the Pacific Garden Mall and Watsonville appear in Figure 1. Figure 2 presents similar data for the area and personal samples taken at the Santa Cruz landfill. In all cases, the majority of the structures seen was less than 2 μm in length; however, there was an apparent increase in structures above 2 μm on the samples from the pump mounted in the bulldozer cab and in those from the breath-

Figure 1— Size Range (Area Samples)

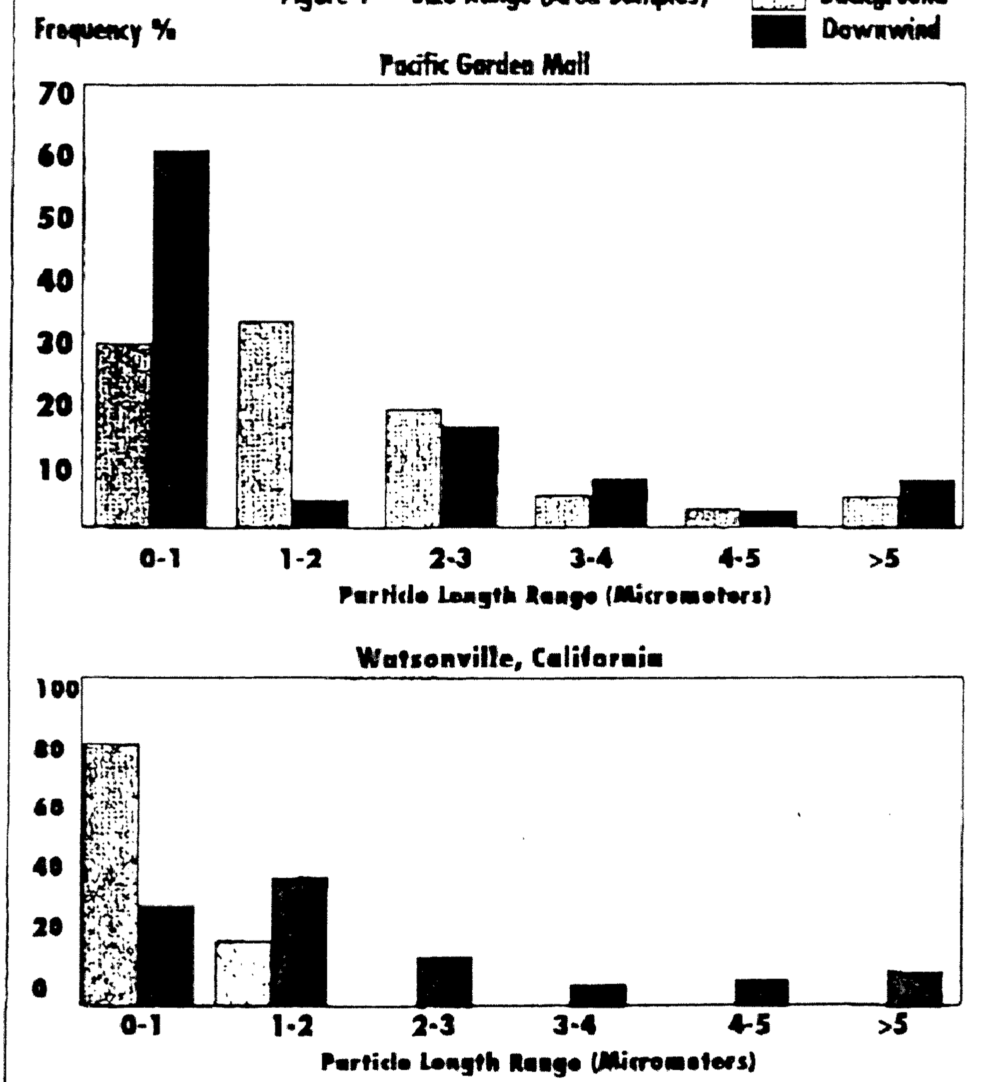
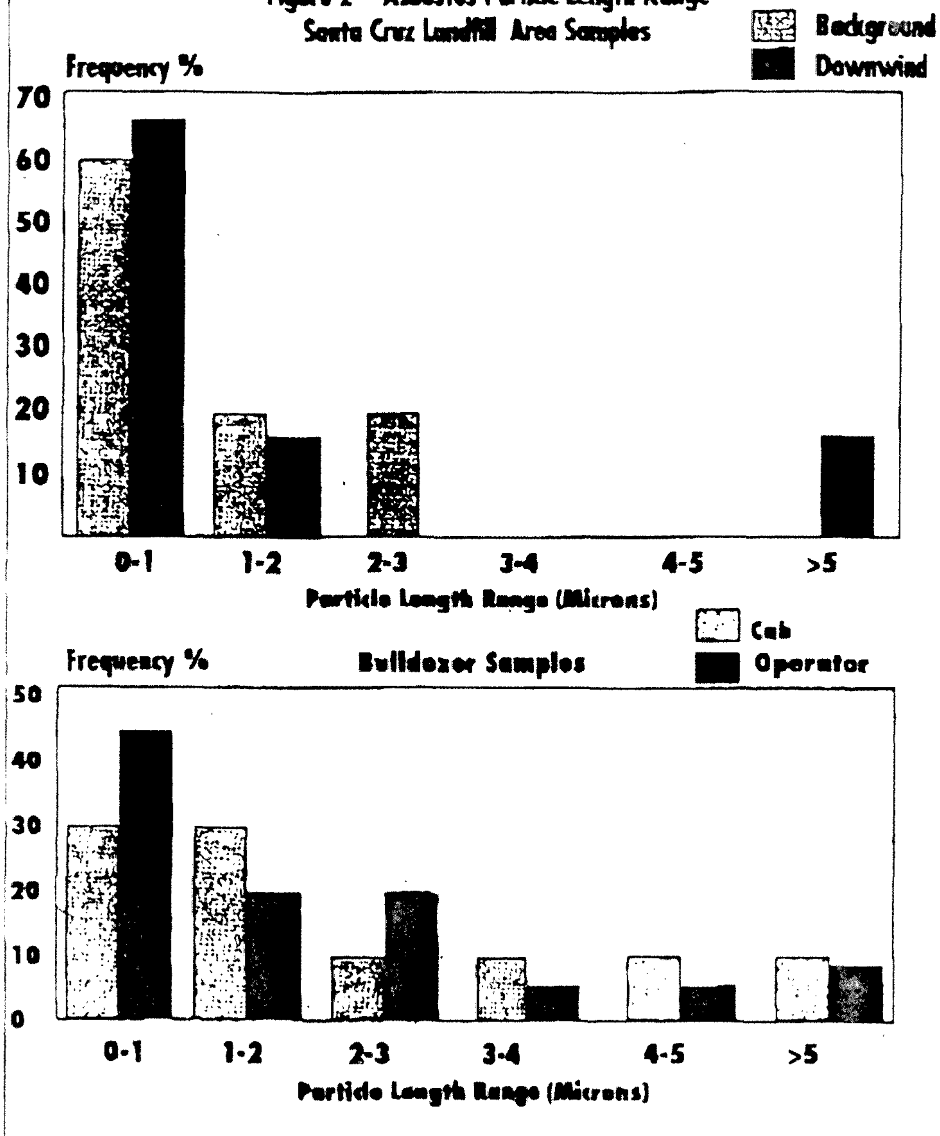


Table II— Asbestos Release During Implosion Demolition

Location	Time Interval Start/Duration	No. of Samples	Mean Air Volume (L)	Concentration Range (s/cc*)	Concentration s/cc (Mean)
Downwind	- 90 min/1.5 hr	3	668	0.0-0.005	0.003
Downwind	+20 min/1.5 hr	3	443	0.04-0.11	0.07
Downwind	+30 min/0.5 hr	1	143	—	0.11
Downwind	+40 min/0.5 hr	1	165	—	0.067
Downwind	+60 min/0.5 hr	1	161	—	0.068
Downwind	+70 min/0.5 hr	1	160	—	0.030

*s/cc = Structures per cubic centimeter
All means are arithmetic.

Figure 2—Asbestos Particle Length Range
Santa Cruz Landfill Area Samples



ing zone of the operator, relative to the area samples. All asbestos structures observed in the area and personal samples contained chrysotile.

Visible emissions were observed during the structural collapse of buildings but were generally not apparent during loading operations when firehoses were used to wet the debris. There were, however, instances of statistically significant elevation ($p < 0.03$) of airborne asbestos levels above background during the handling of debris despite the lack of visible emissions. These limited data support the premise in the National Emission Standards for Hazardous Air Pollutants (NESHAP) (Proposed Rules, January 10, 1989; 40CFR Part 61, page 925) that the absence of visible emission is not sufficient evidence to assume no fugitive particulate emission occurs.

Implosion

RREL was able to monitor an implosion-type demolition of a 26-story building from which all known asbestos (other than vinyl asbestos tile [VAT]) had been removed in full accordance with the provisions of the applicable asbestos NESHAP. Air sampling sites were placed at four quadrants centered about the building at a distance of approximately 500 to 600 feet. Samples were collected downwind prior to the implosion to serve as baseline data. The downwind sampling protocol consisted of one set of samples to be started immediately after implosion which were to run for 1.5 hours. Additionally, two sets of three sequential samples of 0.5-hour duration were collected. One set was started at the time of the detonation, with the second set being started ten minutes later. The initial 1.5-hour samples were overloaded with debris within minutes, so a second set was started approximately 20 minutes after the implosion. The first sample of the two sequential sets was also found to be too heavily loaded to analyze by direct preparation methods. The results from the remaining samples are presented in Table II, with the size range of particles at the various time intervals given in Figure 3. The data showed initially elevated airborne asbestos levels downwind of the site, which rapidly decreased in concentration and size with time. No elevation above background was observed in the other three quadrant samples. Bulk samples of the airborne debris which settled on surfaces at the same distance downwind as the air samples were analyzed by Polarized Light Microscopy and contained trace amounts of chrysotile.

There is no way to assure that all the asbestos originally present in the building was accessible and/or totally removed (except for the VAT, of course, which remained in place).

Our conclusion was that the forces involved in the sudden collapse of a 26-story building provide sufficient energy to make non-friable materials (such as VAT) friable and this may also have contributed to the observed asbestos concentration at the time of the demolition. No control options (such as wetting) were utilized during this demolition; it is difficult, however, to envision control technologies that would be 100% effective in preventing asbestos release considering the massive forces involved in this demolition mode.

Table III— Asbestos Release During Fort Bliss Demolition Activity

Sampling Site	No. of Samples	Mean Air Volume (L)	Concentration Range (s/cc*)	Concentration s/cc (Mean)
Upwind	4	1264	0.0-0.009	0.003
Downwind	19	970 0	.0-0.041	0.014

*s/cc = Structures per cubic centimeter
All means are arithmetic.

Figure 3—Asbestos Particle Length Range (Implosion Demolition)

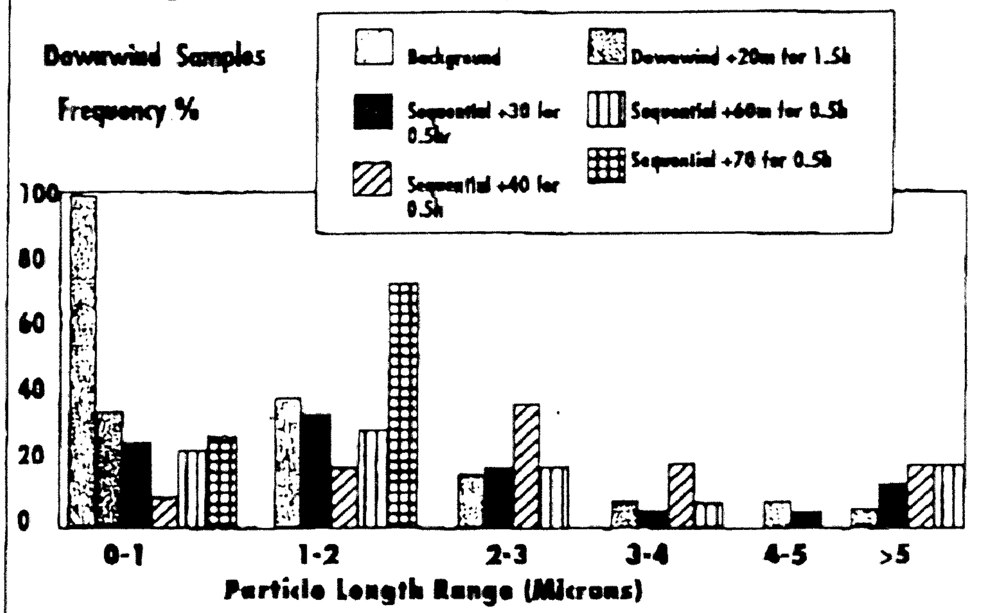
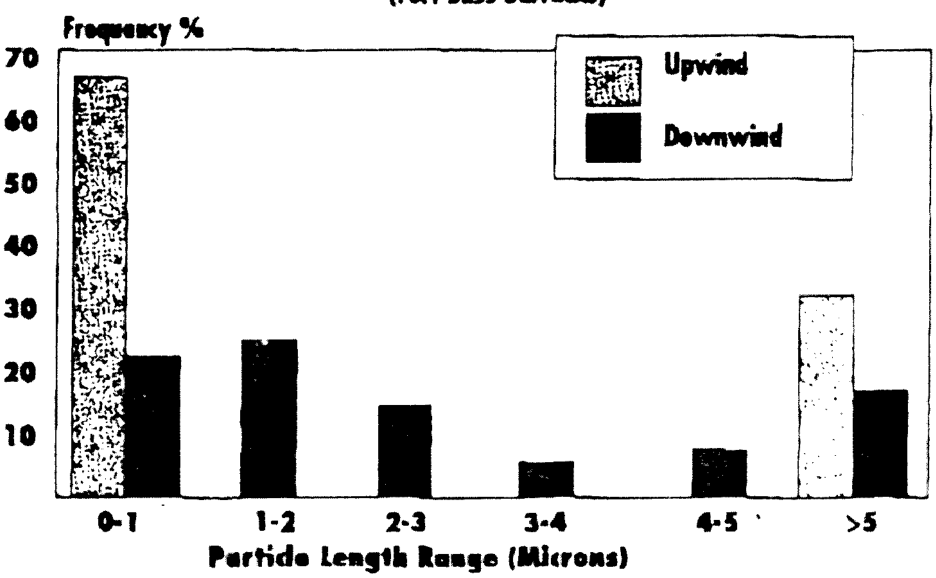


Figure 4—Asbestos Particle Length Range (Fort Bliss Barracks)



U.S. Army — Fort Bliss, El Paso, Texas

RREL assisted the U.S. Army Corps of Engineers, Tulsa District, in evaluating asbestos release during demolition of several two-story wooden barracks. The only known asbestos remaining in the building was VAT that contained as much as 20% chrysotile asbestos over mastic that contained 15% asbestos and caulking compound. The buildings were demolished by a bulldozer and a backhoe with a demolition claw bucket. No wetting was used during the demolition process. This work was done under the auspices of a Federal agency asbestos workgroup known as the Asbestos Development and Demonstration Initiatives Group (ADDIG), which is comprised of the EPA, components of the Department of Defense (DoD) (including the Air Force, Navy, Army, and DoD Dependents Schools) and several other federal agencies.

Air samplers were placed at varying heights and distances downwind of the demolition site. Dust collection samplers were placed at four locations near the upwind and selected downwind sampling sites and were open for the duration of the corresponding air collection period (approximately seven hours.) The dust samples were analyzed at MVA, Inc. using an experimental indirect preparation protocol. A large number of air and personal samples were collected and sent to an independent laboratory for analysis and will be reported by the Corps of Engineers. Subsets of these samples were analyzed by the EPA-RREL TEM Laboratory. The results of the EPA air samples are presented in Table III, with the accompanying size distributions in Figure 4. The asbestos struc-

Table IV— Asbestos Release During Demolition and Disposal
Aurora Elementary School

Sampling Site	No. of Samples	Mean Air Volume (L)	Concentration Range (s/cc*)	Concentration s/cc (Mean)
Upwind	24	2112	0.0-0.004	< 0.001
Downwind	32	2295	0.0-0.028	0.002
Dump Downwind	6	1906	0.0-0.002	< 0.001
PERSONAL SAMPLES				
Backhoe	8	380	0.004-0.176	0.040
Truck Driver	6	425	0.0-0.10	0.003
Dump Cat	1	390	—	0.009

*s/cc = Structures per cubic centimeter
All means are arithmetic.

Table V—Asbestos Release During Demolition and Disposal
Fort Wainwright School

Sampling Site	No. of Samples	Mean Air Volume (L)	Concentration Range (s/cc*)	Concentration s/cc (Mean)
Upwind Day 1	4	2555	0.0-0.002	< 0.001
Downwind Day 1	15	2019	0.0-0.020	0.002
Dump Downwind Day 1	2	2305	—	< 0.002
Upwind Day 2	0	—	—	—
Downwind Day 2	8	1974	0.0-0.003	0.001
Dump Downwind Day 2	2	2421	—	0.0

*s/cc = Structures per cubic centimeter
All means are arithmetic.

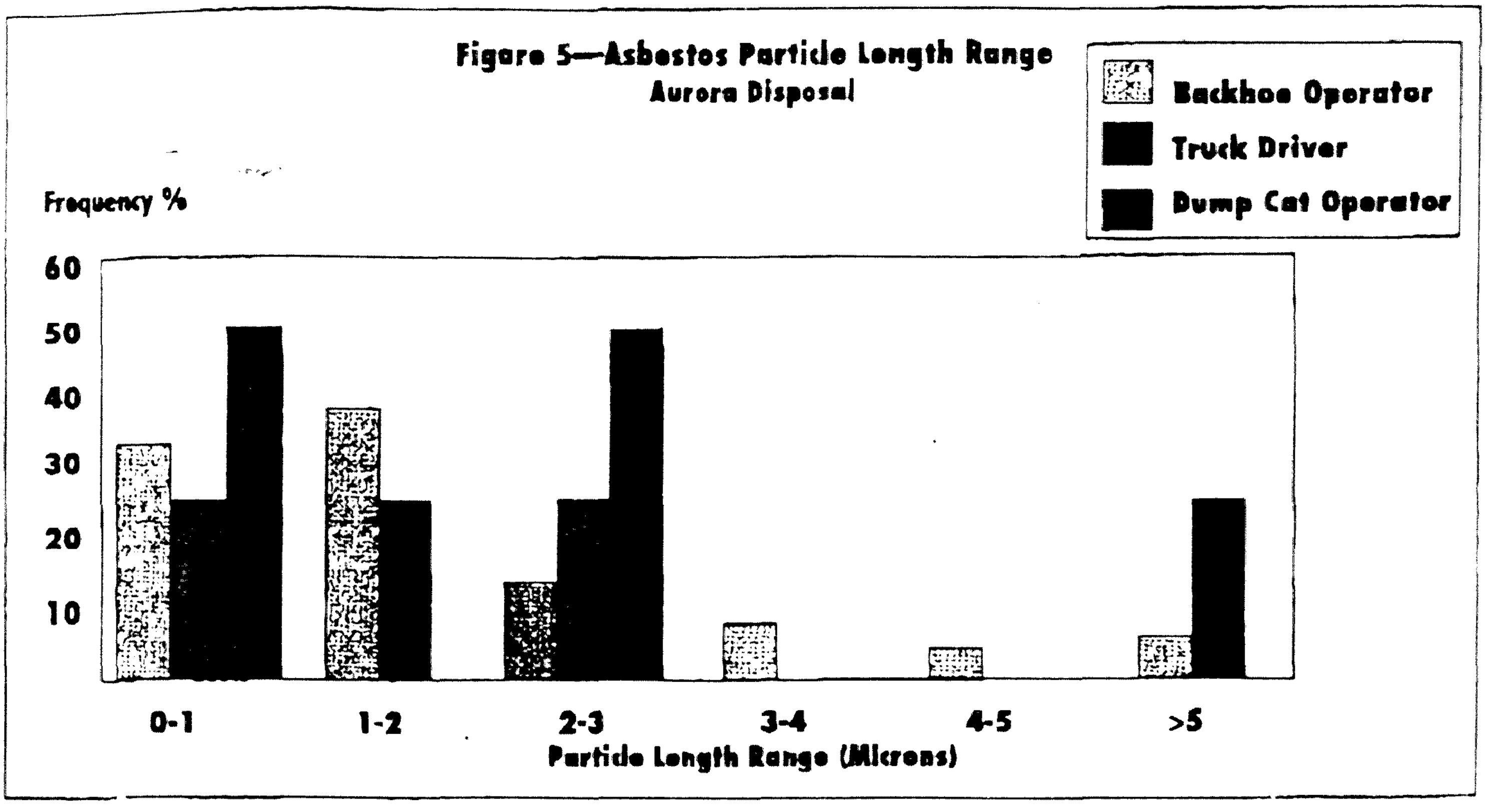
tures found were a mixture of chrysotile and amosite. The presence of a significant number of amosite fibers indicates that there was some source other than the floor tile. No asbestos was found by MVA in the bulk dust samples. An official report of this study is in preparation and will be available from the Army Corps of Engineers. Preliminary findings indicate that there was no statistically significant elevation of TEM asbestos concentrations downwind of the site[3]. Personal samples (PCM) all fell below the limit of detection when counted according to the NIOSH 7400 method, and were therefore in conformance with the Occupational Safety and Health Authority (OSHA) standards for worker exposure.

U.S. Army — Fort Wainwright, Alaska

RREL assisted U.S. EPA Region X and the Fairbanks North Star Borough in evaluating asbestos release from the demolition of two block and frame school buildings on Fort Wainwright in Fairbanks, Alaska. All friable asbestos had been removed from both buildings in accordance with the asbestos NESHAP, leaving only vinyl asbestos tile (between 3 and 7% chrysotile) and asbestos-containing roofing material (as high as 20% chrysotile). The demolition was done by large backhoes and front end loaders that loaded the debris into trucks for transportation to the dump. EPA monitored emissions from the first site and a Certified Industrial Hygienist (CIH) with the Fairbanks North Star Borough monitored the worker exposure. All samples taken from the second site were collected by the CIH. The demolition workers made an attempt during the study to wet the debris with water from a tank truck during active demolition. The wetting effort was marginally successful as an insufficient volume of water was applied to the site. Nature assisted somewhat in this regard as there was intermittent rain during the demolition of the first building. All samples from the first site (Aurora Elementary) were collected over a three-day period. Samples from the second site (Fort Wainwright) were collected over a two-day period.

TEM levels from the Aurora Elementary building (Table IV) averaged well below 0.005 asbestos s/cc, which is negligible, and there was no statistically significant (all p values were > 0.05) difference between the upwind and downwind asbestos levels. A single spike of asbestos release (0.096 s/cc) was observed in one sample as detected by TEM. All structures found contained chrysotile ≤3 µm in length with the exception of one amphibole fiber (actinolite). There were no significant releases of asbestos observed by TEM analysis in the downwind samples at the dump site. TEM levels from the Fort Wainwright school were also negligible (Table V). The downwind samples from the two days of demolition activity had a total of twelve observed chrysotile asbestos structures, all ≤1.5 µm in length.

The worker exposure levels as determined by PCM were all below the OSHA action level of 0.1 f/cc. TEM examination of the personal samples was conducted to identify and quantitate the actual concentration of asbestos fibers longer than 0.5 µm. The results appear in Table IV and Figure 5. The operations performed by the backhoe and truck drivers caused the highest exposure concentrations (as opposed to time-weighted-averages, including a



number of chrysotile fibers over 5 µm long and several long amphibole fibers including amosite, tremolite and actinolite. Tremolite and actinolite may have been present in the floor tile as they often occur as "contaminants" of the chrysotile used. Amosite was the most common amphibole and suggests the presence of an unidentified source.

Summary

These four studies include three sites in which the friable asbestos had been removed prior to demolition (Fort Bliss, Fairbanks, and the implosion site) and two sites in which no pre-demolition removal had been done (Santa Cruz and Watsonsville).

While these few number of sites cannot be considered as representative of all demolition activities, the sites where the friable asbestos had been removed prior to demolition had no statistically significant (where p values were < 0.05) increase in the downwind asbestos concentration as a result of the demolition activity, except in the case of the implosion technique. The sites where no pre-removal was done experienced several instances of brief, statistically significant elevations of downwind asbestos concentrations. None of the personal samples exceeded the OSHA action level when measured by the NIOSH 7400 PCM method; however, the presence of chrysotile and amphibole fibers on these samples as revealed by TEM would indicate that these activities should be closely monitored.

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Author Affiliations

[A] R. C. Wilmoth, P.J. Clark, B.A. Hollett, T.J. Powers: Water and Hazardous Waste Treatment Research Division, Risk Reduction Engineering Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[B] K.A. Brackett. IT Corporation. 11499 Chester Road, Cincinnati, Ohio 45246.

[C] J. R. Millette, Ph. D., MVA, Inc. 5500 Oak Brook Parkway, Norcross, Ga. 30093.