# Health Hazards to Construction Workers During the Demolition of Two Tenement Buildings

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The Center to Protect Workers' Rights (CPWR) — the research and development arm of the Building and Construction Trades Department, AFL-CIO — is uniquely situated to serve workers, contractors, and the scientific community. A key CPWR activity is to improve safet and health in the U.S. construction industry. This report is part of that effort and was developed through a subgrant between CPWR, the New York Department of Health, and Mount Sinai School of Medicine as part of a cooperative agreement between CPWR and the National Institute for Occupational Safety and Health (NIOSH). Federal monies spent on this project: $150,161 (1992).



## Abbreviations

| | |
|---|---|
| AIHA | American Industrial Hygiene Association |
| FEP | Free erythrocyte protoporphyrin |
| HEPA | High-efficiency particulate air filter |
| mcg/dl | Micrograms per deciliter |
| NIOSH | National Institute for Occupational Safety and Health |
| OSHA | Occupational Safety and Health Administration |

# Contents

In March and April of 1992, the New York City Department of Health and the Mount Sinai Occupational Health Clinical Center conducted two health and environmental assessments during the demolition of two tenement buildings in the Bronx, New York. The New York City Department of Housing Preservation and Development, which funded the demolition, required that the contractor cooperate with the Department of Health in conducting the assessment. This included allowing access to the sites and workers to perform exposure and biological monitoring of the workers while the work was under way.

This report presents results of the industrial hygiene and safety evaluations and health assessment of lead exposure. Although the buildings were demolished as part of two projects, both will be discussed in this single report. The buildings were similar in construction and were demolished by one contractor using similar methods.

# Background

## Description of Sites

Site 1 was a tenement building totaling six stories — including the basement — on the southwest corner of Beekman Avenue and 141st Street. The building had been previously abandoned and all the windows and doors had been sealed with cement block. The construction was consistent with pre-war materials including wood floors and joists supported by perimeter brick walls. The interior walls and ceilings were all finished with plaster supported on a wood lath. The roof was wood construction and was flat, and covered with asphalt-impregnated roll roofing. The heating system used steam radiators. The researchers were not able to enter the basement to see whether a boiler still existed. There were three separate apartments on each floor reached by a central staircase. Fire escapes were on the building's west and north perimeter walls. An empty lot was on the west side of the building and an occupied tenement was on the north side. Before beginning the demolition, the contractor erected a sidewalk shed of timber and wood sheathing along the east and south walls of the building.

Demolition of site 1 started on March 16 and was completed March 28. The crew consisted of twelve laborers, one foreman, and one supervisor. In addition, an outside contractor provided a burner who removed the fire escapes and iron fencing by March 20.

The tenement building at site 2 was five stories, including the basement. This building had also been abandoned and the windows sealed with wood sheathing. The building construction consisted of wood floors and joists supported by perimeter brick walls. The interior walls and ceilings were finished with plaster on a wood lath. In some stairway locations plaster on a wire lath was observed. This wire lath material was probably installed during renovations. The flat roof was of wood construction covered with asphalt-impregnated roll roofing material. The heating system consisted of a boiler in the basement with steam pipes and radiators for heat distribution throughout the building.

The ground floor consisted of two commercial spaces and the upper three floors contained two apartments per floor. Access to the apartments was by a central stairway. There was no exterior fire escape on this building. The street abutted the north wall, a small one-story structure was located along the east wall, and tenement buildings were along the west and south walls.

Demolition of site 2 started on April 2 and was completed April 13. The crew consisted of twelve laborers, one foreman, and a supervisor. Two laborers and the foreman worked at both sites.

## Demolition Method

**For demolition of both buildings,** the workers used hand tools. No heavy equipment or power tools were used during the major portion of the demolition. The building utilities had been disconnected before the project began. The demolition work at site 1 took place in the following phases:

- The contractor first erected a sidewalk shed around the north, west, and south perimeter walls. The shed was constructed of wood timber and sheathing consisting of old wood doors.

- Demolition began at the top floor. Workers removed large sections of the floor sheathing, leaving the wood joists in place. Narrow sections of floor were left as runways along the length of the building. These runways were approximately two feet wide and were intended as walking and working surfaces for the workers during the remainder of the demolition. The plaster ceiling below the joists on the floor was also demolished during this process. This work was done using axes and pry bars.

- The floors below were opened up following the same pattern. This procedure created openings through which debris could fall from any part of the building to the basement.

- After the interior of the building had been opened, as described above, the remainder of the interior structures and perimeter were demolished by workers using axes, sledgehammers, and pry bars. Again, work started at the roof and each floor was completely removed from the top down. The crew removed one to two floors per workday.

- The exterior fire escapes were removed using an oxygen acetylene torch.

- At the completion of the hand demolition work, the first floor remained intact — with debris filling the basement and first floor.

- The contractor informed the researchers that the first floor and debris would be removed using a front-end loader. One week after the building was demolished, this work had not been started. So, the researchers were unable to monitor it.

Except for minor differences, the work at site 2 proceeded as described above.

# Research Methods

## Health Assessment

At the beginning of demolition of site 1, the researchers conducted a health assessment of the demolition workers. This assessment was repeated at site 2 toward the end of the demolition work. The assessment consisted of a blood-lead screening and an occupational health interview. The contractor was responsible for inviting all employees involved in the demolition work at the time of the screening to participate. Participation was completely voluntary. Workers were asked at the time of the screening to sign a consent form permitting the Department of Health to release the results of the testing to their respective employers and unions. Participants were notified in writing (by mail and at the site) of the results of their blood-lead tests. The employer was notified by mail.

The most common method of detecting recent lead exposure is by measuring the lead levels in blood. Blood-lead levels are measured in micrograms per deciliter of whole blood (mcg/dl). Everyone is exposed to small amounts of lead in soil, water, food, and air. Blood-lead levels under 10 mcg/dl generally indicate background lead exposure from these sources. Blood-lead levels above 10 to 15 mcg/dl may indicate additional lead exposure from other sources. Levels between 25 and 39 mcg/dl are considered elevated and are reportable to the New York City and New York State Health Departments. Levels above 40 mcg/dl indicate significant lead absorption and should be medically evaluated.

Another common measure of the biological effects of lead is the level of free erythrocyte protoporphyrin (FEP). An elevated FEP level may indicate that lead has interfered with the body's production of hemoglobin in the body. FEP is also measured in micrograms per deciliter of whole blood. Levels below 50 mcg/dl are within normal range; levels from 50 to 150 mcg/dl are considered somewhat elevated; levels above 150 mcg/dl may indicate excessive lead absorption. (A high FEP can also indicate other blood disorders, such as anemia.)

Blood samples were taken from the workers' antecubital veins (in front of the elbow). The blood was analyzed for total lead FEP by the New York City Department of Health Bureau of Laboratories. Specimens were analyzed for blood lead using atomic absorption spectrophotometry (Heller method) and the FEP determinations were done by the Piomelli method. (The Heller and Piomelli methods are standard.)

## Industrial Hygiene Assessment

The industrial hygiene evaluation included personal monitoring to test for the presence of airborne lead, dust, and asbestos; bulk sampling to analyze for the presence of asbestos; and an assessment of respirator use, work practices, and hygiene facilities.

### *Personal airborne-lead monitoring*

Personal air monitoring was conducted at site 1 on five workers on March 20 and at site 2 on one worker on April 8 and on two workers on April 10. Workers were monitored while performing typical tasks throughout the project. Exposure was monitored in each worker's breathing zone. Air was drawn at an approximate rate of 2 liters per minute through a filter cassette by means of a personal air pump attached to the worker's belt. The cassette was fastened to the worker's outer garment at the shoulder. Filter cassettes were Gelman pre-assembled 37 mm diameter 0.8 micron mixed cellulose ester. All samples were analyzed for lead following NIOSH method 7300 by an AIHA-accredited laboratory.

Monitoring was conducted for the length of time that demolition work was performed. The worker burning the metal fire escape and iron fence was sampled only for the 2 hours he was on site. Lead concentrations were measured in milligrams per cubic meter of air ($mg/m^3$). Results were calculated in terms of the number of minutes workers were monitored (real-time estimates) and 8-hour time-weighted averages.

### *Total-dust personal monitoring*

"Total" dust includes all particles that are small enough to be inhaled through the nose and throat. Personal monitoring for total dust was conducted at site 1 on March 20 and March 25 and at site 2 on April 8. The sample cassettes contained 5-micron polyvinyl chloride (PVC) filters that were preweighed, assembled, and analyzed by an AIHA-accredited lab following NIOSH method 0500. Samples were run in the workers' breathing zone with the personal pumps operated at an approximate flow rate of 2 liters per minute. Monitoring was conducted for the length of time that the demolition work was performed. Dust levels were measured in milligrams per cubic meter of air. Results were calculated in terms of the number of minutes that workers were monitored (real-time estimates) and 8-hour time-weighted averages.

### *Respirable-dust personal monitoring*

Respirable dust is small enough to penetrate to the lower parts of the lung. In general, the sample of respirable dust weighs less than total dust. Personal monitoring for respirable dust was conducted at site 1 on March 25 and at site 2 on April 8. The sample cassettes contained 5-micron PVC filters that were preweighed, assembled, and analyzed by an AIHA-accredited lab. Sampling was conducted by attaching an SKC, Inc. cyclone to the filter cassette and sampling in the workers' breathing zone. The personal sampling pumps were calibrated at a flow rate of about 1.7 liters per minute. Samples were run during the entire time demolition work was conducted. The respirable dust levels were measured in milligrams per cubic meter of air collected. The results were given as 8-hour time-weighted averages.

### *Personal-air monitoring for asbestos*

Air monitoring was conducted at site 2 on April 10 where bulk samples had indicated the presence of asbestos. The samples were taken and analyzed according to NIOSH method 7400 using 25 mm cassettes with 0.8 micron mixed-cellulose ester filters. The cassette was attached to the worker's collar with the personal sampling pump operated at a flow rate of about 0.6 liters per minute. Samples were run for those periods when demolition was taking place. Results are reported in fibers per cubic centimeter (f/cc). Results were calculated in terms of the total minutes the workers were sampled (real-time results) and the 8-hour time-weighted average.

### *Asbestos bulk sampling*

Bulk samples of demolition debris were collected and analyzed for asbestos. Decisions about where to collect samples were based on observation of suspect materials. Samples of roofing material, floor tiles, and wall and ceiling plaster were taken and analyzed using polarized light microscopy.

### *Work practices and hygiene assessment*

Respirator use, work practices, and hygiene facilities were assessed through a combination of employee interviews and observations during periodic onsite inspections.

### Safety Assessment

Safety practices — including materials handling and protection from fires and falls — were assessed. Because the building electricity was disconnected and there was no temporary power, electrical safety was not a concern.

## Results

### Health Assessment

Largely because of poor contractor cooperation, only two workers participated in the blood-lead screening. They were members of different locals of the Laborers'

International Union of North America. Each was tested twice — at site 1 on March 20 and at site 2 on April 8.

One of the demolition workers had an initial blood-lead level of 16 mcg/dl (table 1). The other worker had an initial blood lead of 30 mcg/dl. In the second test, during the final stages of the demolition of site 2, the blood-lead level for the first worker had increased slightly (by 2 mcg/dl) while the other worker's level had decreased (by 6 mcg/dl).

The initial FEP results were 47 mcg/dl and 48 mcg/dl, respectively (table 2) — just within the normal range. At the second test, one worker showed no change and the other worker's FEP had increased to 51 mcg/dl.

## Industrial Hygiene Assessment

### *Personal airborne-lead monitoring*

*Site 1.* Results of airborne-lead monitoring of the demolition workers showed an 8-hour time-weighted average ranging from 0.003 $mg/m^3$ to 0.011 $mg/m^3$ (table 3). The burner was exposed to 0.663 $mg/m^3$ during the removal of the fire escape and the iron fence, which took a little more than two hours. This equals an 8-hour time-weighted average of 0.180 $mg/m^3$.

*Site 2.* The exposures ranged from 0.006 $mg/m^3$ to 0.032 $mg/m^3$, 8-hour time-weighted average.

### *Total-dust personal monitoring*

*Site 1.* Total dust exposure for the demolition workers ranged from 4.27 to 11.6 $mg/m^3$, 8-hour time-weighted average (table 4).

*Site 2.* The only dust sample taken showed a level of 2.49 $mg/m^3$, 8-hour time-weighted average.

### *Respirable-dust personal monitoring*

One respirable dust sample was taken at each location. Respirable dust levels — at the 8-hour time-weighted average — were 3.39 $mg/m^3$ at site 1 and 1.31 $mg/m^3$ at site 2 (table 5).

### *Personal-air monitoring for asbestos*

*Site 2.* Because of the large quantities of airborne dust generated during the demolition project, a number of the filter cassettes had so much dust on them that they were overloaded and could not be analyzed by light microscopy. One sample was run at a very low flow rate (approximately 0.6 liters per minute) and was found to have less than the limit of detection given the volume collected (0.027 f/cc).

### *Asbestos bulk sampling*

*Site 1.* At this site, all bulk samples were found to be asbestos-free by analyses using polarized light microscopy.

*Site 2.* The roofing material contained approximately 5 percent chrysotile asbestos, mixed with cellulose and asphalt. Chrysotile asbestos was the most commonly used asbestos type in building materials in the United States. The plaster was found to contain trace levels (less than 1 percent) of chrysotile asbestos. The boiler and piping systems were all uninsulated. The floor tiles were found to be asbestos-free.

### *Respiratory protection*

The workers were not provided with respiratory protection at either location. There was no evidence of a respiratory program (which would include training). Five workers brought their own respirators. These consisted of single-use dust masks (three workers) and half-face dual-cartridge respirators (two workers) with high-efficiency particulate air filters (HEPA). These two workers were the only ones who participated in the blood-lead screening program. The remainder of the work force wore no respiratory protection.

### *Hygiene facilities*

No hygiene facilities were available at either site. There was no change room, no provision for wash-up, and no soap or towels. There were no toilet facilities. Workers usually used the first floor of the building as a toilet.

## Safety Assessment

The following safety problems were found to be common to both sites. Applicable sections of the OSHA Construction Standard (CFR 1926) are cited.

- Workers were not provided with personal protective equipment such as hard hats, safety shoes, or gloves. Workers were expected to bring their own equipment. In general, workers were permitted to work on site without personal protective equipment. (CFR 1926.100 (a).)

- No provision was made to adequately protect the workers or pedestrians from being struck by falling objects. The sidewalk bridge built around the building to protect pedestrians had so much debris on it that debris began bouncing into the street. (CFR 1926.252 (a) (b), and 1926.25)

- Walls were pulled down as entire units, causing the release of large amounts of debris in an uncontrolled fashion. This also created structural loading problems on lower floors and on the sidewalk bridge. (CFR 1926.854 (a))

- No steps were taken to prevent workers from falling. No safety rails (perimeter guarding), lifelines, nets, or other equipment were used to protect workers from falls. (CFR 1926.104 (a))

- The sheathing on the floors was removed in most areas, requiring workers to walk and work on wood joists or along the perimeter brick wall. (CFR 1926.500 (b)8, .853, and .850 (i))

- There was no fire protection at either site, as required by New York City Fire Department regulations during building demolition. The contractor did not run a hose from the fire hydrant in the street into the building. (CFR 1926.150)

- Work practices were extremely hazardous. Workers often stood on top of a brick wall while breaking the bricks out beneath them. They also stood on joists that were no longer anchored. (CFR 1926.500 (b))

- There was no site security. Measures were not taken to prevent people — including children — from entering the building during off hours.

## Discussion

The health and safety investigation pointed up several potential safety and health hazards at this site.

Residential building demolition using hand tools potentially creates a great deal of dust. If no attempt is made to control dust, workers are surrounded by clouds of it — as was the case during the demolition of the two buildings. The results of the dust monitoring, with a range of 2.5 $mg/m^3$ to 11.6 $mg/m^3$ (8-hour time-weighted average) indicate significant dust exposures to the workers. Although most of the results are within the OSHA dust standard of 15 $mg/m^3$, the results are close enough to the standard to be of concern, especially because chronic exposure to high dust levels has been associated with chronic bronchitis.

The presence of lead and asbestos in the dust is of particular concern. One important result of this investigation is that airborne lead was detected during the hand demolition of painted walls, ceilings, and other surfaces. Although the lead levels were generally low when compared with the current OSHA standard, one of the levels was above the OSHA action level of 30 $mcg/m^3$. These results demonstrate that workers are potentially exposed to lead while engaged in residential building demolition. The finding of no significant change in the lead levels of the two workers tested could reflect the fact that these were the only workers who had minimally adequate protection. Because the participation rate in blood-lead testing was low, comparisons with other workers on the basis of blood-lead levels could not be made.

The airborne lead monitoring results also indicate high lead exposures generated during the burning of the lead-painted steel fire escape and fencing at site 1 (0.663 $mg/m^3$). Although the burner finished his task in two hours, the high exposure level indicates a need for respiratory protection. None was used.

Lead not only endangers workers; it can be released into the environment, settling on neighboring surfaces, including buildings and apartments, sidewalks, and children's play areas. Settled lead dust becomes a potential source of exposure to community residents — including children, who are particularly sensitive to its effects.

The total dust and respirable dust levels were below the OSHA standards for the 8-hour time-weighted average. But the real-time results exceeded the standard for two of the samples. During demolition, significant clouds of visible dust were released in the work area and into the surrounding neighborhood. Reducing the dust levels could be easily accomplished by hosing down work areas during demolition.

The presence of asbestos-containing roofing material among the demolition debris indicates that asbestos removal prior to building demolition — as required by New York City and state law — was incomplete. Although asbestos in roofing is subject to regulation because it is not considered friable (easily crumbled by hand pressure) by the Environmental Protection Agency's National Emission Standards for Hazardous Air Pollutants, the removal and disposal of this material is regulated by the New York State Department of Labor and New York City Department of Environmental Protection. These regulations require that a state-licensed asbestos contractor remove the roofing, using licensed workers. Work practices must include the use of a worker shower facility, wet removal methods, and equipment using HEPA filtration. The roofing waste must also be disposed of as asbestos-containing material.

Asbestos was present in the plaster in trace amounts and is not regulated in these amounts. This means that the contractor can legally treat the material as ordinary construction debris. The fibers in air samples taken during the demolition at site 2 indicate that fiber levels remained well below the OSHA standards. Nonetheless, the demolition of the asbestos-containing plaster is likely to result in some increased asbestos exposure to workers.

One of the most troubling aspects of these investigations is that the generation of dust is readily controlled using wet methods long established in the demolition industry. Because no attempt was made to employ wet methods at the two demolition sites, the workers were exposed to lead and potentially asbestos, as well as total dust.

Because dust control procedures were not followed, respiratory protection would have been the next line of defense against worker exposures. At these sites, however, the contractor supplied no respirators and there was no respiratory protection program. In addition, there was not even the most rudimentary hygiene facility. In such dusty conditions, workers must have a place to wash before breaks, at lunch, and after work — as well as a place to change from work clothes to street clothes. Otherwise, there is a risk of family members being inadvertently exposed to asbestos or lead dust carried home on workers' clothing.

***Table 1. Blood-lead test results — demolition workers***
*(mcg/dl)*

| *Worker* | *Test 1 (3/20/92)* | *Test 2 (4/8/92)* | *Days between tests* |
|---|---|---|---|
| *1* | 16 | 18 | 19 |
| *2* | 30 | 24 | 19 |

***Table 2. FEP test results — demolition workers***
*(mcg/dl)*

| *Worker* | *Test 1 (3/20/92)* | *Test 2 (4/8/92)* | *Days between tests* |
|---|---|---|---|
| *1* | 47 | 47 | 19 |
| *2* | 48 | 51 | 19 |

***Table 3. Personal airborne lead monitoring results***
*March and April 1992*

| *Sample number* | *Time (minutes)* | *Result ($mg/m^3$)* | *8hr. time-weighted average ($mg/m^3$)* |
|---|---|---|---|
| *Site 1* | | | |
| *1* | 311 | 0.009 | 0.006 |
| *2* | 227 | 0.023 | 0.011 |
| *3* | 170 | 0.007 | 0.003 |
| *4* | 405 | 0.004 | 0.003 |
| *5* | 130 | 0.663 | 0.180 |
| *Site 2* | | | |
| *1* | 450 | 0.006 | 0.006 |
| *2* | 413 | 0.037 | 0.032 |
| *3* | 440 | 0.006 | 0.006 |

***Table 4. Total dust personal monitoring results***
*March and April 1992*

| *Sample number* | *Time (minutes)* | *Result ($mg/m^3$)* | *8hr. time-weighted average ($mg/m^3$)* |
|---|---|---|---|
| *Site 1* | | | |
| *1* | 348 | 8.73 | 6.33 |
| *2* | 347 | 15.3 | 11.6 |
| *3* | 436 | 4.70 | 4.27 |
| *4* | 290 | 17.9 | 10.81 |
| *Site 2* | | | |
| *1* | 419 | 2.85 | 2.49 |

***Table 5. Respirable dust personal monitoring results***
*March and April 1992*

| *Sample* | *Time (minutes)* | *Result ($mg/m^3$)* | *8hr. time-weighted average ($mg/m^3$)* |
|---|---|---|---|
| *Site 1* | 429 | 3.79 | 3.39 |
| *Site 2* | 350 | 1.79 | 1.31 |