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CAMBRIDGE

ASBESTOS FIBER CONCENTRATIONS IN AIR FROM SPRAY FIREPROOFING OPERATIONS USING ZONOLITE PRODUCTS

PLAINTIFF'S
EXHIBIT

WRG-1596

In order to determine concentrations of airborne asbestos during and after the application of vermiculite-asbestos cement materials in the fireproofing of structural steel, observations were made at three construction sites in San Francisco on May 26, May 28 and June 4, 1970. Consideration was given to the actual and potential exposures of (a) workmen carrying out the spray operation, (b) workers in allied trades nearby, and (c) the general public.

Sites studied. Three spray operations were surveyed: (1) the Embarcadero Center, where Mr. G. Connell was spray contractor; (2) the P.G. and E. Headquarters Building, where the spray contractor was C & R Plastering, Inc. (Mr. Rasmussen); and (3) the Hilton Towers, where Mr. G. Connell was also the contractor.

Methods. Airborne fiber concentrations were determined by drawing air through Millipore type AA filters, with 0.8µm mean pore size. Samples were taken in the breathing zones (BZ) of men working with the material and at various locations surrounding the operations. Air flows ranged from 0.11 cubic feet per minute (cfm) in breathing zones to 1.8 cfm in areas more distant. Portions of the filters were mounted on slides, and the fibers in 100 microscopic fields counted, using phase contrast microscopy at a magnification of 430x. The numbers of asbestos fibers seen were converted to concentrations, expressed in fibers per milliliter of air, by taking into account the area counted, the flow rate, and the sampling time.

Results.

Embarcadero Center - May 26, 1970. Spraying was being conducted on the 41st floor of the 43-story building. The three men at work at this site were all plasterers; there were no hodcarriers. The plasterers moved their own stores but did not clean the area as they worked. The floor of the work site was covered to an estimated depth of two inches with rebound and oversprayed fireproofing materials. The gun from which the material was being applied was being operated at a relatively high air flow rate, resulting in considerable rebound.

Samples were taken (A) of the air in the breathing zones (BZ) of the gun operator and the man moving the stage from which the operator was working; (B) of the air in the area surrounding the spray operation; (C) of the air moving through the 43rd floor (2 floors above the spray operation); (D) of the air in the breathing zone of the investigator

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as he moved around the spray operation (equivalent to the exposure which might be experienced by a construction worker in the area); (E) of the air in the breathing zone of the mixer operator working on the ground floor (Table I).

TABLE I
EMPARCADERO CENTER AIR SAMPLES

Sample Number	Area	Asbestos fibers	
		total f/ml	f/ml (>5 um)*
54 (A)	Spray operator's BZ	7.96	6.54
51 (A)	" " "	2.63	2.18
49 (A)	" " " (Held near back of head to protect face of filter)	3.56	3.18
47 (A)	Stage mover's BZ	1.86	1.55
2249 (B)	Area near spray (1-50 feet distant, some direct spray on filter)	0.030	0.028
2250 (C)	Background area, 43rd floor (air flow past spray-encrusted drapes)	0.020	0.016
56 (D)	Investigator's BZ	0.79	0.60
48 (E)	Mixing Operator's BZ	0.775	0.710

*Present tentative occupational threshold limit value of 5 f/ml is based on fibers greater than 5 micrometers in length.

P C & E Building - May 29, 1970. A crew of 6, with two guns operating simultaneously, was at work on the 21st floor. The first impression on arriving at the work site was of cleanliness and order. The hod-carriers, when not moving the stages, were scraping the floor near each stage, and moving the accumulated rebound and overspray fireproofing material to a large central pile for removal. There was a business-like atmosphere, and the crew appeared to be efficient. It was noted that moving of the stages was accomplished, for the most part, without request from the gun operator, but on the initiative of the hod-carriers. The spray used here appeared to be drier than at the previous site, and was being applied at a lower velocity and flow rate. The finished sprayed surface appeared to be somewhat rougher, but the build-up from leaving the gun in one place too long was less, leading to a more comfortable working pace for the operator and less direct rebound on his face and person. Samples were taken: (A) in the breathing zone of the gun operator; (D) in the breathing zone of the investigator

(equivalent to the breathing zone exposure of the hod-carriers; (C) upwind and downwind (approximately) of the stages, in the general area of the stages; (D) in the breathing zones of the mixer operators; (E) in the general area of the mixing operations; (F) one floor below the spray operations; and (G) in the general area of spray operations (Table II).

TABLE II
PG&E AIR SAMPLES

Sample Number	Area	Asbestos Fibers	
		Total f/ml	f/ml*(>5 μm)
53 (A)	Spray operator's BZ	3.32	2.91
1 (A)	" " "	3.15	2.64
55 (B)	BZ of investigator, close to spray stage, walking with hod-carrier	0.16	0.14
2 (C)	Area, ± 40 feet upwind of single stage (air flow variable)	0.13	0.11
3 (C)	Area, ± 40 feet downwind of stage (air flow variable)	0.25	0.23
60 (D)	Mixing operator's BZ (wind away from)	0.50	0.42
52 (D)	Mixing operator's BZ (wind toward)	1.42	1.25
59 (E)	Mixing area (between two mixing operators)	1.09	0.98
61 (E)	Mixing area (between two mixing operators)	1.34	1.14
2147 (F)	Background, 1 floor below spray operations, most air flow not through the building to filter, but variable.	0.014	0.011
4 (G)	Area, between two stages (current to pump cut off at variable times, total flow through filter uncertain)	0.038	0.036
5 (G)	Area, ± 30 feet from stages (2)	0.071	0.061
2149 (G)	Area, ± 35 feet from stage, (air flow in area uncertain and variable)	0.36	0.34

*Present occupational threshold limit value of 5 f/ml is based on fibers greater than 5 micrometers in length.

Hilton Towers - June 4, 1970. Spray operations were underway on the 21st floor of this building. There was a steady westerly wind through the building. A second gun crew was spraying stairways on the 35th and 31st floors. The job site was clean and orderly in appearance (considering the nature of the operation), and the hod-carrier was cleaning the floor as the stage was moved. The air flow rate and rate of application was somewhat higher than on the P C & E job, but not as high as on the first job. The mixing area was in the basement of the building, but there was a good flow of air through the mixing area, secondary to the high wind speeds aloft. Air samples were taken in (A) the spray operator's breathing zone, (B) the hod-carrier's breathing zone, (C) upwind and downwind of the area of the spray stage, (D) on the upwind side of the building on the 35th floor (the uppermost level at which continuous flooring had been installed), (E) downwind of the 17th floor, (F) in the mixing operator's breathing zone, and (G) in the area of the mixing operation (Table III).

TABLE III

HILTON TOWERS AIR SAMPLES

Sample Number	Area	Asbestos	
		total f/ml	f/ml*(>5 um)
62 (A)	Spray operator's BZ	2.48	2.20
64 (B)	Hod Carrier's BZ	0.49	0.33
2264 (C)	Upwind of stage	0.0007	0.0007
2262 (C)	Downwind of stage	0.0147	0.0137
73 (D)	Upwind of 35th floor - Background (Prob. non-iso-kinetic flow at filter face; validity as a final measure of fiber background level?)	none seen	none seen
2259 (E)	Downwind of 17th floor (four floors below spray operators)	0.0017	0.0017
57 (F)	Mixing operator's BZ	1.61	1.45
69 (F)	Mixing operator's BZ	0.55	0.50
63 (G)	Mixing Area	0.43	0.38

* See note tables I and II.

Ambient Air Sampling. Air samples were taken in upwind and downwind street areas around the Hilton Towers on June 23, 1970. Pumps drawing air through Millipore filters at flow rates from 0.057 to .11 cubic feet per minute were used. A total of 8 samples were taken; 4 upwind and 4 downwind, 2 upwind and 2 downwind samples were taken in the morning and afternoon (Table IV). The samples in the upwind area (west of the hotel) were of two kinds: stationary samples (in parking lot of the 500 block of Leavenworth Street), and "moving"

samples (in the general area bounded by Turk, Jones, Post, and Hyde streets). The moving samples were taken by an investigator wearing a filter holder. The downwind samples were taken in the same way. Stationary samples were taken at two locations: the morning sample from an open window (2nd floor level) at 150 Powell Street and the afternoon sample on the roof of a parking lot office one block west of the Hilton. (The moving samples were taken in the area bounded by Market, Grant, Geary and Mason streets.)

TABLE IV

Air Sampling Results
(fibers/ml)

	Upwind	Sensitivity*	Downwind	Sensitivity*
Morning				
Stationary	0.024	0.005	0.016	0.016
Moving	0.014	0.005	0.042	0.009
Afternoon				
Stationary	0.077	0.009	0.015	0.005
Moving	0.009	0.005	0.005	0.005

* Minimum fiber concentration on filter is 1 fiber per 100 fields observed. Sensitivity is inversely proportional to the volume of air passed through the filter.

Discussion. The occupational exposures to spray operators were not above the currently recommended threshold limit values for asbestos exposures, which have recently been recommended for reduction to 5 f/al (fibers over 5 micrometers in length) based on a time-weighted average over an 8 hour work day, 5 days a week. Only one sample higher than this level was found. The wide variability is normal for this type of operation. Nevertheless, there is little margin of safety and the potential risk from asbestos inhalation is such that we would recommend that exposures be reduced even further. Concentrations dropped off rapidly in the adjacent areas and may reach levels of the ambient air.

Background or ambient air concentrations ranged from less than 1 fiber per liter of air (upwind high in Hilton Towers) to 77 fibers per liter at ground level upwind at Hilton Towers. The variability reflected the variety of wind conditions during the study, multiple construction projects in the downtown area, as well as inherent sampling variations. There is no way to estimate the contribution of the fireproofing spray jobs being studied to the overall background fiber level in San Francisco. In other studies, in East Bay, we have found the average asbestos fiber concentrations to be approximately 1 f/liter, but sometimes going as high as 12 f/liter.

Since confusion may arise from using different units to describe concentrations of fibers in work areas and in ambient air, the ranges of concentrations expressed uniformly as fibers per liter have been grouped in Table V.

TABLE V

CONCENTRATIONS OF ASBESTOS FIBERS IN AIR EXPRESSED IN FIBERS PER LITER

Value at site	Range: fibers/liter
Proposed occupational threshold limit value (ACGIH).....	5,000*
Spray crew breathing zones	
Gun operator.....	2,480 - 7,960
Stage mover.....	490 - 1,860
Mixing operator.....	500 - 1,610
Adjacent work areas on same floor.	1 - 360
Work areas on other floors.....	<1 - 14
Vicinity of buildings being sprayed.	
Upwind.....	9 - 77
Downwind.....	5 - 42
Ambient air in Bay Area.....	<1 - 12
*Fibers over 5 μ m in length other values not corrected for this.	

The threshold limit value for occupational exposures proposed by the American Conference of Governmental Industrial Hygienists has been included for reference (TLV). Exposures of spray crews averaged below the TLV; workers in adjacent areas of the same buildings were exposed to concentrations from 1/10 to 1/5000 of this value; individuals on other floors of the buildings and in the building vicinities had transitory exposures ranging from 1/100 to 1/5000 of the TLV; ambient air levels in the Bay Area were from 1/500 to less than 1/5000 of this value. Direct extrapolation from recommended occupational levels to the community is certainly not justified, but in the absence of ambient air or emission standards, the TLV provides a point of reference. It does not take into account 24-hour-a-day exposures, or the fact that children may be exposed with the potential for a longer lifetime of retention. Even with these reservations, the concentrations measured to date in ambient air do not appear alarming. Since unnecessary exposures to asbestos should be prevented and community contamination kept to a minimum, we encourage all practicable measures to contain materials and prevent fiber dissemination.

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