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HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 90-151-L2067
DEPARTMENT OF ENERGY
WESTSIDE ENERGY CO-OP
DENVER, COLORADO
SEPTEMBER 1990

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

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NIOSH INVESTIGATORS:
Charles McCammon, CIH
Steven Lee, CIH

I. INTRODUCTION

On January 26, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Director of the Regional Support Office of the Department of Energy (DOE) to provide technical assistance to a local weatherization agency following a citation from the Occupational Safety and Health Administration (OSHA). The company, Westside Energy Co-Op, had been cited for failing to monitor worker exposure to asbestos during the weatherization of homes containing asbestos. During the period of March through May, 1990, a total of approximately 30 homes were visited during weatherization operations. Air sampling was conducted by NIOSH investigators in 12 of these homes for asbestos and total dust.

II. BACKGROUND

The DOE weatherization program has been ongoing for many years and provides home weatherization to low-income families. The purpose of the program is to reduce energy consumption by providing home weatherization and education on energy usage. Weatherization of homes includes patching the major holes and leaks in the houses, putting insulation wrap on hot water pipes and hot water heaters, adding attic or sidewall insulation, and educating the home owners on ways to reduce energy consumption through proper use of furnaces, keeping windows closed, etc.

Westside Energy CO-OP is a non-profit company which conducts weatherization of low-income homes using funds provided by the Department of Energy and disbursed by the Colorado Department of Housing. At the time of the request, Westside employed twenty workers involved in site visits to private homes. The process generally starts with energy auditors who first visit the homes and assess the amount of leakage of outside air into the homes using a blower door technique. The blower door is a fan mounted in a cloth-covered flexible frame which is fitted into the front door and tightly sealed, except for the fan exhaust area. The fan is used to create a negative or positive pressure in the home (negative pressure is the most common technique) to quantify the amount of leakage of outside air into the house. This method is also used by the general heat waste technicians to locate leaks that need to be plugged. Most leaks are plugged with a one-part urethane foam. Furnace technicians go to the houses at about the same time and evaluate furnace performance and tune-up the furnace. Repair technicians also make minor home repairs, but only as they pertain to improved weatherization. Insulation technicians blow cellulose insulation into the attic and outside walls. After all the work is done, inspectors do a final blower door test to determine how much improvement was achieved at the house and to insure all work is completed.

III. MATERIALS AND METHODS

The NIOSH evaluation consisted of determining which homes might contain asbestos; conducting air monitoring for asbestos during all phases of weatherization operations in asbestos-containing homes; collecting bulk samples to verify the presence of asbestos and determine asbestos type and amount; and collecting total dust samples during insulation operations. The presence of suspected asbestos-containing material (ACM) was determined visually by the Westside auditors and the NIOSH investigators, and was verified by bulk sample analysis. Initially, homes were randomly visited and if suspected asbestos-containing material was encountered, samples were collected. Only two of the first 12 homes visited had suspected ACM. To optimize sampling in homes containing ACM, the later strategy was to visit only those homes identified by the Westside Energy auditors as having suspected ACM.

A. Air samples were collected at 1-2 liters per minute using Gilian Hi-Flow personal sampling pumps. Samples were collected on 25-millimeter, cellulose ester membrane filters housed in a conductive, cowled cassettes. Sample volumes were kept low, due to the high level of general dust in the attics, crawl spaces, and basements.

B. All bulk samples were analyzed according to NIOSH Method No. 9002 which utilizes polarized light microscopy[1]. Portions of each sample were immersed in Cargille liquid having a refraction index of 1.55 and examined under polarized light at a magnification of 100x for type and percent of asbestos.

C. Air samples were analyzed according to NIOSH method 7400[2]. This method utilizes phase contrast microscopy to size and count the fibers. The limit of detection is 3000 fibers per filter for 25 millimeter diameter filters. Subjective comments about the fiber type on the filters were also indicated by the laboratory.

D. If air samples were found to contain high fiber counts and the subjective comments concluded that there was asbestos present, these samples were analyzed by transmission electron microscopy (TEM) to verify the presence and quantity of asbestos. The TEM analysis was conducted according to Revision #1 of NIOSH method 7402[3]. Samples were examined at a magnification of 10500x and energy dispersive x-ray analysis and, if needed, selected area electron diffraction were employed in fiber identification.

EVALUATION CRITERIA

A. General

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most

workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, such contact may increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of air contamination criteria generally consulted include: (1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs); (2) the American Conference of Governmental Industrial Hygienist's (ACGIH) Threshold Limit Values (TLVs); and (3) the U.S. Department of Labor (OSHA) federal occupational health standards. These sources provide environmental limits based on airborne concentrations of substances to which workers may be occupationally exposed in the workplace environment for 8 to 10 hours per day, 40 hours per week for a working lifetime without adverse health effects.

B. Asbestos

Increased health risk resulting from occupational exposure to asbestos has been well documented in the scientific literature. Initially, asbestos was associated with a chronic and debilitating lung disease called asbestosis which normally occurred following long-term exposures to high levels of asbestos fibers. Epidemiologic studies show that there is a correlation between the intensity and duration of asbestos exposure and an observed excess in several types of cancer, including mesothelioma (a rare cancer of the chest and abdominal lining) and cancers of the lung, esophagus, stomach, and colon. These cancers usually appear many years after the initial contact with asbestos, and sometimes result from short-term and/or low level exposures[4-10].

NIOSH recommends that occupational exposure to asbestos be eliminated or, if it cannot, the exposure should be controlled to the lowest level possible[11]. This recommendation is based on the proven human carcinogenicity of asbestos and on the absence of a known safe threshold concentration. From the available evidence, NIOSH has concluded that asbestos is a carcinogen capable of causing,

independent of smoking, lung cancer and mesothelioma. It is NIOSH's contention that there is no safe concentration of exposure to asbestos. NIOSH investigators, therefore, evaluate workplaces under the premise that there should be no detectable levels of asbestos. In the absence of other information, the finding of a detectable level of asbestos indicates a need for further evaluation of the work environment or the implementation of recommendations to reduce exposure.

The Federal Occupational Safety and Health Administration (OSHA) standard for asbestos limits exposure to 0.2 fiber/cc (>5 um in length) averaged over an 8-hour workday[12]. OSHA has also established an asbestos excursion limit for the construction industry that limits worker exposures to 1.0 fiber/cc averaged over a 30-minute exposure period[13]. There is also a provision for the medical monitoring of workers routinely exposed to levels in excess of 0.1 fibers/cc. This exposure standard was devised to minimize the risk of developing asbestosis. The ACGIH TLV includes 0.2 fiber/cc for crocidolite, 0.5 fibers/cc for amosite, and 2 fibers/cc for chrsotile and all other forms of asbestos[14].

C. Total Dust

Particulate aerosols which do not show a marked toxic effect and are not otherwise classified are lumped into a category of nuisance dusts. These dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Exessive exposures to nuisance dusts in the workplace may reduce visibility, may cause unpleasant deposits in the eyes, ears, and nasal passages, or cause injury to the skin or mucous membranes. The current OSHA PEL for Particulates Not Otherwise Classified (PNOC) is 15 milligrams per cubic meter of air (mg/m3) measured as total dust[12]. The ACGIH has a TLV of 10 mg/m3 for PNOC measured as total dust[14].

V. RESULTS

Table 1 is a summary of all the personal breathing zone and area air monitoring results for asbestos. While some of the fiber concentrations were above the NIOSH REL of 0.1 f/cc, the subjective analyses of the microscopist only identified four samples that actually contained asbestos. Most of the fibers on the samples were cellulose and some were fiberglass. Two of the air samples containing asbestos had very low fiber counts. The other two air samples were analyzed by TEM and were found to contain little or no asbestos.

Table 2 summarizes the analyses of bulk samples collected from the various homes. During the NIOSH study, Westside workers suspected that seven materials contained asbestos, and bulk sample analyses confirmed that all of these materials did contain asbestos. The analyses showed that all of the suspected pipe or duct wrap contained chrysotile asbestos in concentrations ranging from 20 to 70%.

The bulk #SL-3 (Table 2) was analyzed to verify that "Insulsafe" insulation was mineral wool and to determine the size and shape of the fibers in this insulation material. The sample contained numerous fibers which were typlified as being very long, thin fibers. The average fiber was 0.5 micrometers (um) in width (range of 0.09 to 3.2 um) and greater than 20 um in length (range of 1.8 to 68 um).

The results of the samples collected for total dust during insulation operations are summarized in Table 3. These samples were all personal breathing zone samples collected on workers who wore half-face piece respirators with HEPA/Organic Vapor Cartridges. Significant dust levels were encountered during all types of insulation work, however, the highest dust levels were found during attic blowing operations (>40 mg/M^3). Due to the small, cramped quarters, the hose on the sample pump on the one worker blowing insulation in an attic came loose in the last few minutes of operation so the actual total dust levels are not known. The company had a written respirator program covering use while blowing insulation material.

A bulk sample of the cellulose insulation was analyzed for boric acid content (boron was actually measured). The boric acid is used as a flame retardant. The cellulose insulation contained 5.8% by weight boric acid.

VI. DISCUSSION AND CONCLUSIONS

A number of different variables were considered when collecting airborne asbestos samples. There was a concern that the blower door technique might cause settled asbestos fibers to become airborne. Several different samples in different houses where asbestos was present in a variety of locations failed to demonstrate any problem caused by the blower door technique. This included the general living space, attics, and basements. Other situations that were sampled included: 1) movement throughout a dirt crawl space where pieces of old asbestos duct wrap were found, 2) the cleaning of a furnace which had friable asbestos wrap on the furnace or ducts leading from the furnace, 3) general heat waste activity in an attic where old asbestos wrap was found, and 4) final inspection of a house where friable asbestos existed on ducts.

Westside has developed a policy of avoiding work in homes with large amounts of friable asbestos, particularly those where the asbestos would have to be disturbed to conduct various weatherization operations. The bulk sample analyses demonstrated that the workers can successfully identify asbestos-containing material.

Furthermore, none of the homes samples demonstrated any significant amount of airborne asbestos. Therefore, Westside was successfully avoiding any homes that looked problematic. There is no question that the workers are exposed to high levels of dusts and cellulose fibers. However, their respirator program was such that any worker entering an attic, crawl space, or knee wall, or were spraying cellulose insulation, wore a half-face respirator with a combination HEPA/Organic Vapor cartridge. Workers involved in attic spraying of insulation have complained of occasional eye irritation. The boric acid used as a fire retardant is a known eye and mucous membrane irritant.

VII. RECOMMENDATIONS

1. Westside should continue their program of identifying asbestos-containing material in client homes and avoiding potentially hazardous homes.

2. New workers should be educated on asbestos identification, health hazards associated with asbestos, and avoidance of exposure.

3. Individual homeowners should notified if suspected asbestos-containing material is identified in their home. The EPA booklet titled "Asbestos In The Home, A Homeowner's Guide" should be handed out for informational purposes.

4. Attic insulation workers should wear eye protection during exposure to boric acid treated cellulose insulation. This could include goggles, or preferably, the use of full-face piece respirators.

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Table 1
Personal and Area Air Monitoring Results for Asbestos
Westside Energy Co-op
Denver, Colorado

House Address (date)	Sample #	Volume (liters)	Conc. (f/cc)	Subjective Comments*	Comments
4981 Julian (3-12-90)	W-A-02	60	0.064	No asbestos	Sample near old gravity furnace
2605 Hooker (3-12-90)	W-A-03	90	0.21	51% fiberglass	In crawl space, asbestos shingle fragments laying about
4776 High (3-27-90	W-A-05	108	0.08	7% fiberglass	Furnace repair, old furnace replaced
3541 Locust (4-18-90)	W-A-06	198	0.15	cellulose	Personal, final house inspection
	W-A-10	146	0.07	cellulose	Area, behind furnace
3440 Jackson (4-18-90)	S-A-11	168	0.06	cellulose	Area, next to furnace during blower door testing
2100 Niagra (4-18-90)	W-A-07	70	<0.04	no fibers	Area, next to furnace during blower door test
	W-A-08	79	<0.04	no fibers	In center of house during blower door test
	W-A-09	24	1.8	cellulose	Personal, moving around crawl space, near asbestos wrap
1630 Sheridan (4-25-90)	W-A-12	46	0.67	cell, fg, asb$	Personal, general waste heat work in attic
	W-A-13	46	0.76	cell, fg, asb#	Personal, continuation of #W-A-13
	W-A-14	107	<0.03	cell, asb	Area, background in living room
330 Galapago (4-25-90)	W-A-15	85	0.04	cell, asb	Personal, during blower door
	W-A-90	119	<0.03	cellulose	Area, in basement near asbestos source during blower door test
3540 Alaska (4-25-90)	W-A-17	27	2.0	mineral wool	Personal, gen waste heat work in attic

f/cc = number of fibers per cubic centimeter of air
*Analysis by Phase Contrast Microscopy (PCM); analyst's comments about fiber type: Cell = cellulose fibers, fg = fiberglass fibers, asb = asbestos fibers
$ = Transmission Electrom Microscopy (TEM) analysis revealed no asbestos present.
# TEM analysis revealed fibers contained 3% chrysotile asbestos.

Table 2
Summary of Bulk Sample Analysis of Weatherization Homes
Westside Energy Co-Op
Denver, Colorado
March-April, 1990

House Address	Bulk #	Bulk Analysis	Comments
4981 Julian	B-W-02 B-W-03	15-20% cotton 20-25% chrysotile 20-25% cotton	Settled dust sample near furnace Pipe lagging off gravity flow furnace
2605 Hooker	B-W-04	3-5% chrysotile	House shingle, parts scattered in crawl space
3541 Locust	B-W-10	20-30% chrysotile	Part of duct connection wrap in 50-yr old house, original ducts (furnace new)
3440 Jackson	B-W-11	50-60% chrysotile	Bulk roll of asbestos wrap found in plastic bag in attic
2100 Niagra	B-W-12	50-60% chrysotile	Loose duct wrap found throughout crawl space
1630 Sheridan	SL-1	40-50% chrysotile	Duct wrap found loose in attic
330 Galapago	SL-2	60-70% chrysotile	Duct wrap from old furnace, very friable
3540 Alaska	SL-3	100% mineral wool	"Insulsafe" insulation in attic

Analysis by Polarized Light Microscopy (PLM)

Table 3
Summary of Personal Air Sampling results for Total Dust
Westside Energy Co-Op
Denver, Colorado
April 27, 1990

Sample #	Time (min)	Volume (liter)	Concentration (Mg/M^3)	Comments
FW-4710	54	65	4.6	Blowing walls with insulation
FW-4376	40	48	13.8	Trying to get insulation blower running
FW-4375	34	36	2.2	Working on insulation blower
FW-5144	49	52	4.3	Dumping 30# bags of insulation into hopper at rate of 4 bags in 3 minutes
FW-5142*	50	60	≥40.8*	Blowing cellulose insulation in attic

* Sampling hose became unhooked with the last 5-10 minutes of sample, so result was probably higher.

NOTE: All workers wore half-face respirators with combination HEPA/Organic Cartridges.