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HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT NO. TA 79-4

NATIONAL ZOOLOGICAL PARK
WASHINGTON, D.C.

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Office of Police and Safety
National Zoological Park
Washington, D.C.

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Abstract (Limit: 200 words)

Environmental and personal air samples and ceiling, wall, and floor dust bulk samples were analyzed for the presence of asbestos (133221A) at the National Zoological Park Reptile House (SIC-8421), Washington, D.C. on November 9, 1978. The evaluation was requested by the Office of Police and Safety at the zoo on behalf of an unspecified number of workers and the general public. The visitor and service areas had no detectable airborne asbestos fibers. The ceiling sample contained 70 percent chrysotile-asbestos (12001295), but no asbestos was detected in wall and floor samples. The investigators note that the OSHA standard for asbestos is an 8 hour time weighted average airborne concentration not to exceed 2,000,000 asbestos fibers longer than 5 microns per cubic meter (cu m) of air, with ceiling concentrations never to exceed 10,000,000 fibers longer than 5 microns/cu m. They conclude that airborne asbestos fibers are not a potential health hazard to workers or to the public in the Reptile House. They recommend that roof leaks and damaged hot water pipes covered with asbestos be repaired, the asbestos ceiling be removed completely when the building is renovated, and bulk samples of floor sweepings be analyzed every 6 months until renovation is completed.

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Hazards-unconfirmed, Air-sampling, Dust-analysis, Health-surveys, Asbestos-dusts

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I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) conducted an environmental survey of the National Zoological Park Reptile House, on November 9, 1978.

It has been determined, based on environmental sampling and work place observations that a potential health hazard to airborne asbestos fibers does not exist for working personnel, or the public in the Reptile House at this time.

NIOSH recommends that occupational exposures to asbestos (a human carcinogen) be kept as low as possible. The NIOSH recommended level for occupational exposure to asbestos is 100,000 fibers >5u in length per cubic meter of air (Fibers/M^3) for an 8-hour time-weighted average (TWA) daily exposure.

The recommended standard is intended to protect against noncarcinogenic effects and reduce the risk of asbestos-induced cancer.

II. INTRODUCTION

At the request of the Chief, Office of Police and Safety, National Zoological Park, Washington, D.C., the National Institute for Occupational Safety and Health (NIOSH), conducted an environmental evaluation of the Zoo's Reptile House.

The purpose of the study was to assess potential health hazards associated with the asbestos insulated ceiling of the Reptile House.

The study was conducted on November 9, 1978. This report presents the findings and conclusions of the NIOSH investigator.

III. EVALUATION

A. Description of Facilities

The Reptile House is a permanent fixture made of cement foundation, brick walls, a metal roof, and occupies approximately 16,000 square feet (sq. ft.). The arched ceiling inside the Reptile House is sprayed and troweled with a 2 to 3 inch thick material that contains 70 percent chrysotile asbestos (as determined by a NIOSH contracted analytical laboratory). Two roof exhaust fans are located in each of the four corridors that form the basic perimeter of the public viewing area. Behind the public viewing area is located the service lines, commissary, and animal holding areas. These areas do not have asbestos covered ceilings, but do have asbestos insulated hot water pipes. The basement of the Reptile House also has many hot water pipes insulated with asbestos.

The asbestos ceiling is deteriorating in various spots in the building because of rain and a leaking outside roof. The asbestos insulated hot water pipes located behind and below the public viewing area are cracked, peeled, and flaked in certain areas throughout the building.

B. Toxic Effects[1,2,3,4]

Asbestos is a fibrous mineral with excellent insulating, fireproof and acoustical properties. Asbestos is capable of producing nonmalignant and malignant respiratory diseases. Asbestosis, a pulmonary fibrosis is a nonmalignant chronic disease characterized by progressive dyspnea (difficult breathing), and cough; and usually leads to death within 15 years. Pulmonary infections are very common to these patients.

The malignant disease develops in different tissues and forms. Epidemiological evidence has shown that some workers exposed to asbestos developed mesothelioma (a cancer of the lung lining specific for asbestos), or tumors in the pleural, peritoneal, or gastrointestinal tissues. The threshold of the carcinogenic response is unknown and the latency period may be 40 years or more before the malignancy is found. There is no known "safe" exposure limit.

The respiratory effects of inhaled asbestos fibers* are potentiated by smoking.

C. Environmental Criteria

The following environmental criteria presently exist for occupational exposures to asbestos.

Source	TWA**	Fibers/M3* Ceiling***	Peak****
NIOSH[2]	100,000	-	500,000
ACGIH[5] (Chrysotile)	2,000,000	-	-
OSHA[6]	2,000,000	10,000,000	-
OSHA (Proposed)[2]	500,000	5,000,000	-

*Fibers >5 u in length per cubic meter air
**8-hour time-weighted average daily exposure
***value never to be exceeded
****peak value based on a fifteen minute sample

The NIOSH Criteria are designed to protect the average worker against the noncarcinogenic effects of asbestos and reduce the risk of asbestos induced cancer. Although data exists that show the lower the exposure, the lower the risk of developing cancer, there is no evidence at the present time that a "safe" level of exposure exists. Only a ban on the material could assure protection against the carcinogenic effects of occupational asbestos exposures.[2]

*A fiber is defined as a particle with a length to diameter ratio greater than or equal to 3:1.

D. Environmental Investigation

A total of 12 personal and general area samples for asbestos were collected on 0.8 micron (u) pore size AA Millipore* cellulose ester filters using MSA* Model G gravimetric pumps operated at airflows of 1.7 liters per minute (lpm). The filters were held in an open face three piece cassette. Area asbestos samples were taken in the visitor areas, in service areas "C" and "F", and in the basement. Personal samples were taken during morning sweep-up, and during routine reptile feeding operations.

The samples, including two blank filters, were analyzed by phase contrast microscopy. The results of these samples and environmental conditions are presented in Table 1.

Ceiling, wall, and floor dust bulk samples were collected in glass scintilation vials. The ceiling sample contained 70 percent chrysotile asbestos, while no asbestos was detected from the wall and floor dust samples. All bulk samples were analyzed by X-ray diffraction, electron microscopy with elemental analysis, and phase contrast microscopy with polarizing and dispersion staining techniques.

IV. DISCUSSION/RECOMMENDATION

The data generated by this study indicates that although asbestos is present in the Reptile House ceiling material, the visitor and service areas had no detectable airborne asbestos fibers. This information is based on personal, general area, and bulk samples.

The outside environmental condition for the sampling day was sunny and the temperature was in the mid-forties. It is felt that rain and wind would not significantly alter the exposure conditions inside the Reptile House at this time. However, if roof leaks are not repaired deterioration of the asbestos ceiling could accelerate and pose a future potential health hazard.

Some of the asbestos covered hot water pipes that were cracked and peeled were repaired with fibrous glass sleeves at the time of this investigation. According to a spokesman from Facilities Management, all damaged asbestos covered pipes would be repaired in the building.

Complete renovation of the Reptile House is scheduled for fiscal year 1981 or 1982, according to the Chief of Police and Safety. At this time, removal or covering of the asbestos ceiling is being planned.

*Mention of manufacturer's name does not constitute a NIOSH endorsement.

Regulations pertaining to protective equipment and permissible exposures to asbestos can be found in the Federal Register 29 CFR 1910.1001, 1976 (Appendix A).

Any method used to remove and dispose of the material should meet all Department of Labor Standards contained in 29 CFR 1910.1001.

In order to protect the health and safety of employees and the visiting public of the Reptile House, the following recommendations are made.

1. Repair all roof leaks. Repair work should begin as soon as feasible to assure no further damage to ceiling integrity.

2. Continue repair and patchwork of all damaged hot water pipes covered with asbestos.

3. Bulk samples should be collected every 6 months from floor sweepings in the Reptile House and sent to a certified analytical laboratory to monitor asbestos fallout. If asbestos counts begin to rise, then there may be a potential health hazard. The semi-annual bulk sampling should continue until renovation of the Reptile House is complete.

4. When renovation of the Reptile House ceiling begins, there are three basic options that can be considered; complete removal of the asbestos ceiling, installation of a suspended ceiling below the original ceiling, paint the asbestos ceiling with an epoxy or latex paint. Of all the options, complete removal of the ceiling is preferred. This option is the most expensive, but is the best method for control of future exposure. Note that every precaution against exposure while removing the ceiling must be made.

The second option is to cover or install an acoustical tile suspended ceiling. If the second option is chosen, an environmental and medical surveillance program will have to be developed and must meet the specifics of 29 CFR 1910.1001, and should meet NIOSH recommended criteria contained in References 1 and 2.

The third option of painting the asbestos ceiling with an epoxy or latex paint is least expensive, but also least desirable. Painting the ceiling is a temporary solution and does not eliminate the possibility of exposure. In addition, the paint adds considerable weight to the ceiling and may cause it to fissure and fall.

The NIOSH investigator would like to thank all participants for the excellent cooperation and assistance received during the survey, and particularly the services of the Health and Safety Officer, National Zoological Park.

V. REFERENCES

1. Criteria for a Recommended Standard ... Occupational Exposure to Asbestos, NIOSH Publication HSM 72-10267.

2. Revised Recommended Asbestos Standard, NIOSH Publication No. 77-169.

3. Documentation of the Threshold Limit Values for Substances in Workroom Air, American Conference of Governmental Industrial Hygienists, 3rd Edition, 1974, Cincinnati, Ohio.

4. Patty, Frank, Industrial Hygiene and Toxicology, Volume II, Interscience, New York, New York, 1967.

5. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1978, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

6. 29 Code of Federal Regulations 1910.1001, Safety and Health Standards, Occupational Safety and Health Administration, Department of Labor, Washington, D.C., 1976.

VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Table 1

Results of Air Sampling for Asbestos
Personal and Area Samples

National Zoological Park
Reptile House

November 9, 1978

Time	Sampled Volume (Liters)	Location	Results Asbestos Concentration fibers/cc*
0740-0900	136	Sweeping Public Area (Personal)	N.D.[1]
0740-0900	136	Sweeping Public Area (Personal)	N.D.
0755-1455	714	"A" Line Feeding Area (Personal)	N.D.
0805-1455	697	"C" Line Feeding Area (Personal)	N.D.
0850-1450	612	"C" Line Feeding Area (C-11)	N.D.
0825-1445	646	C-25 Public Viewing Area	N.D.
0825-1445	646	B-1 Public Viewing Area	N.D.
0915-1450	553	F-14 Line Feeding Area	N.D.
0910-1445	553	Basement, New Dry Foods Storage Area	N.D.
0917-1445	502	D-8 Public Viewing Area	N.D.
--		Floor Sweeping (Bulk Sample)	N.D.
--		Ceiling (Bulk Sample)	70% Chrysotile
--		Public Viewing Wall (Bulk Sample)	N.D.

*Approximate total fibers >5μ in length per cubic meter of air.
1 - Less than 4500 fibers per filter (Non-Detectable).

Table Z-2

Material	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift. Concentration	Maximum duration
Benzene (Z37.4-1969)[1]	10 p.p.m	25 p.p.m	50 p.p.m	10 minutes.
Beryllium and beryllium compounds (Z37.29-1970)	2 μg./M³	5 μg./M³	25 μg./M³	30 minutes.
Cadmium fume (Z37.5-1970)	0.1 mg./M³	0.3 mg./M³		
Carbon disulfide (Z37.3-1968)	20 p.p.m	30 p.p.m	100 p.p.m	30 minutes.
Carbon tetrachloride (Z37.17-1967)	10 p.p.m	25 p.p.m	200 p.p.m	5 minutes in any 4 hours.
Chromic acid and chromates (Z37.7-1971)		1 mg./10M³		
Ethylene dibromide (Z37.31-1970)	20 p.p.m	30 p.p.m	50 p.p.m	5 minutes.
Ethylene dichloride (Z37.21-1969)	50 p.p.m	100 p.p.m	200 p.p.m	5 minutes in any 3 hours.
Fluoride as dust (Z37.28-1969)	2.5 mg./M³			
Formaldehyde (Z37.10-1967)	3 p.p.m	5 p.p.m	10 p.p.m	30 minutes.
Hydrogen fluoride (Z37.28-1969)	3 p.p.m			
Hydrogen sulfide (Z37.2-1966)		20 p.p.m	50 p.p.m	10 minutes once only if no other measurable exposure occurs.
Mercury (Z37.8-1971)		1 mg./10M³		
Methyl Chloride (Z37.18-1969)	100 p.p.m	200 p.p.m	300 p.p.m	5 minutes in any 3 hours.
Methylene Chloride (Z37.23-1969)	500 p.p.m	1,000 p.p.m	2,000 p.p.m	5 minutes in any 2 hours.
Organo (alkyl) mercury (Z37.30-1969)	0.01 mg./M³	0.04 mg./M³		
Styrene (Z37.15-1969)	100 p.p.m	200 p.p.m	600 p.p.m	5 minutes in any 3 hours.
Tetrachloroethylene (Z37.22-1967)	100 p.p.m	200 p.p.m	300 p.p.m	5 minutes in any 3 hours.
Toluene (Z37.12-1967)	200 p.p.m	300 p.p.m	500 p.p.m	10 minutes.
Trichloroethylene (Z37.19-1967)	100 p.p.m	200 p.p.m	300 p.p.m	5 minutes in any 2 hours.

[1] Occupational exposures to benzene are subject to the requirements of Section 1910.1028 except as specifically exempted by Section 1910.1028(a)(2). Exposures exempted by Section 1910.1028(a)(2) are covered by this Section 1910.1000.

[Footnote to Table Z-2 added at 43 FR 5963, February 10, 1978; entry on Lead deleted from Table Z-2 at 43 FR 52952, November 14, 1978, effective February 1, 1979; official corrections at 43 FR 57061, December 8, 1978]

Table Z-3—Mineral Dusts

Substance	Mppcf[1]	Mg/M³
Silica:		
Crystalline:		
Quartz (respirable)[2]	250[3]	10mg/M³[4]
	%SiO₂+5	%SiO₂+2
Quartz (total dust)		30mg/M³
		%SiO₂+2
Cristobalite: Use ½ the value calculated from the count or mass formulae for quartz.		
Tridymite: Use ½ the value calculated from the formulae for quartz.		
Amorphous, including natural diatomaceous earth	20	80mg/M³
		%SiO₂
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (non-asbestos-form)	20[5]	
Talc (fibrous). Use asbestos limit		
Tremolite (see talc, fibrous)		
Portland cement	50	
Graphite (natural)	15	
Coal dust (respirable fraction less than 5% SiO₂)		2.4mg/M³
		or
For more than 5% SiO₂		10mg/M³
		%SiO₂+2
Inert or Nuisance Dust:		
Respirable fraction	15	5mg/M³
Total dust	50	15mg/M³

NOTE: Conversion factors—
mppcf×35.3=million particles per cubic meter
=particles per c.c.

[1] Millions of particles per cubic foot of air, based on impinger samples counted by light-field technique.

[2] The percentage of crystalline silica in the formula is the amount determined from air-borne samples, except in those instances in which other methods have been shown to be applicable.

[3] Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC instrument. If the respirable fraction of coal dust is determined with a MRE the figure corresponding to that of 2.4 Mg/M³ in the table for coal dust is 4.5 Mg/M³.

[Official correction to Table Z-3 at 43 FR 57601, December 8, 1978]

[4] Containing < 1% quartz; if > 1% quartz, use quartz limit.

[5] Talc containing asbestos: Use asbestos limit.

§ 1910.1001 Asbestos.

(a) *Definitions.* For the purpose of this section, (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) *Permissible exposure to airborne concentrations of asbestos fibers*—(1) *Standard effective July 7, 1972.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) *Standard effective July 1, 1976.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Ceiling concentration.* No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(c) *Methods of compliance*—(1) *Engineering methods.* (i) *Engineering controls.* Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) *Local exhaust ventilation.* (a) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2–1971, which is incorporated by reference herein.

(b) See § 1910.6 concerning the availability of ANSI Z9.2–1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(iii) *Particular tools.* All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) *Work practices*—(i) *Wet methods.* Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) *Particular products and operations.* No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) *Spraying, demolition, or removal.* Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d)(2)(iii) of this section and with special clothing in accordance with paragraph (d)(3) of this section.

(d) *Personal protective equipment*—(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of

this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivisions (i), (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 F.R. 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) *Air purifying respirators.* A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) *Powered air purifying respirators.* A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) *Type "C" supplied-air respirators, continuous flow or pressure-demand class.* A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) *Establishment of a respirator program.* (a) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2–1969, which is incorporated by reference herein.

b. See § 1910.6 concerning the availability of ANSI Z88.2–1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms: (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering: (a) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) *Method of measurement.* All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400–450 × (magnification) (4 millimeter objective) with phase contrast illumination.

(f) *Monitoring*—(1) *Initial determinations.* Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) *Personal monitoring*—(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) *Environmental monitoring*—(i) samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) *Sampling frequency and patterns.* After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) *Employee observation of monitoring.* Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) *Caution signs and labels.* (1) *Caution signs.* (i) *Posting.* Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) *Sign specifications.* The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	*Notation*
Asbestos	1" Sans Serif, Gothic or Block.
Dust Hazard	¾" Sans Serif, Gothic or Block.
Avoid Breathing Dust	¼" Gothic.
Wear Assigned Protective Equipment.	¼" Gothic.
Do Not Remain In Area Unless Your Work Requires It.	¼" Gothic.

[Sec. 1910.1001(g)(1)(ii)]

Legend	Notation
Breathing Asbestos Dust May Be Hazardous To Your Health.	14 point Gothic.

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) *Caution labels*—(i) *Labeling.* Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) *Label specifications.* The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) *Housekeeping*—(1) *Cleaning.* All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) *Waste disposal.* Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) *Recordkeeping*—(1) *Exposure records.* Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 20 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either.

[1910.1001(i)(1) amended at 41 FR 11505, March 19, 1976]

(2) *Employee access.* Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) *Employee notification.* Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) *Medical examinations*—(1) *General.* The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) *Preplacement.* The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(3) *Annual examinations.* On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(4) *Termination of employment.* The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(5) *Recent examinations.* No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) *Medical records*—(i) *Maintenance.* Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) *Access.* The contents of the records of the medical examinations required by this paragraph shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of NIOSH, to authorized physicians and medical consultants of either of them, and upon the request of an employee or former employee, to his physician. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

[Section 1910.93a added at 36 FR 23207, December 7, 1971, as emergency temporary standard; issued as permanent standard at 37 FR 11318, June 7, 1972, effective July 7, 1972; redesignated Section 1910.1001 at 40 FR 23072, May 28, 1975]

§ 1910.1002 Coal tar pitch volatiles; interpretation of term.

As used in Sec. 1910.1000 (Table Z-1), coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum, wood, and other organic matter.

[37 FR 24749 Effective November 21, 1972]

§ 1910.1003 4-Nitrobiphenyl.

(a) *Scope and application.* (1) This section applies to any area in which 4-Nitrobiphenyl, Chemical Abstracts Service Registry Number 92933 is manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3), and (4) of this section.

(2) This section shall not apply to solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Nitrobiphenyl.

(b) *Definitions.* For the purposes of this section: (1) "Absolute filter" is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 μm particles.

(2) "Authorized employee" means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Nitrobiphenyl. The clean change room shall be contiguous to and have an entry from a shower room, when the shower room facilities are otherwise required in this section.

(4) "Closed system" means an operation involving 4-Nitrobiphenyl where containment prevents the release of 4-Nitrobiphenyl into regulated areas, nonregulated areas, or the external environment.

(5) "Decontamination" means the inactivation of 4-Nitrobiphenyl or its safe disposal.

(6) "Director" means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health, Education, and Welfare to act for the Director.

(7) "Disposal" means the safe removal of 4-Nitrobiphenyl from the work environment.

(8) "Emergency" means an unforseen circumstance or set of circumstances resulting in the release of 4-Nitrobiphenyl which may result in exposure to or contact with 4-Nitrobiphenyl.

(9) "External environment" means any environment external to regulated and nonregulated areas.

(10) "Isolated system" means a fully enclosed structure other than the vessel of containment of 4-Nitrobiphenyl,