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GUIDELINES: ASBESTOS HANDLING IN THE CHLOR-ALKALI INDUSTRY

ST0447434

Edition 1

November 1978

MEMBER INFORMATION REPORT 137

The Chlorine Institute, Inc., 342 Madison Ave., New York, N.Y. 10017. Additional copies of this pamphlet are available at nominal cost.

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1. INTRODUCTION

1.1 SCOPE

Increased awareness of the health hazards of asbestos, coupled with regulations promulgated by governmental agencies over the past several years, emphasize the desirability of developing guidelines for the safe handling of asbestos fiber and waste products by chlor-alkali producers.

Industry and government share concern and responsibilities to insure the health and welfare of workers and the general public that might be exposed to asbestos, especially that which is airborne and can be inhaled, by providing safeguards to protect them from hazards associated with asbestos mining, transport, fabrication, use and disposal operations.

This pamphlet is limited to considerations relative only to asbestos safe handling and disposal practices applicable to the chlor-alkali industry. Examples of satisfactory asbestos control practices, where given, are intended to be only illustrative and are not to be construed either as having universal applicability or representing the only available or suitable means of control.

1.2 DEFINITIONS

In this pamphlet the following meanings apply:

Asbestos means chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite and, in the case of OSHA regulations, those of such fibers that are longer than 5 micrometers. (The chrysotile variety accounts for most of all fiber used in the U.S.).

CFR means the U.S. Code of Federal Regulations.

DOL means the U.S. Department of Labor.

EPA means the U.S. Environmental Protection Agency.

INSTITUTE means The Chlorine Institute, Inc.

NIOSH means the National Institute for Occupational Safety and Health of the U.S. Department of Health, Education and Welfare.

OSHA means the Occupational Safety and Health Administration of the U.S. Department of Labor.

OSH Act means the U.S. Occupational Safety and Health Act of 1970 (P.L. 91-596).

Particulate asbestos material means finely divided particles of asbestos material.

Visible emissions means any emissions which are visually detectable without the aid of instruments and which contain particulate asbestos material.

1.3 DISCLAIMER

The information in this pamphlet is drawn from sources believed to be reliable. The Institute and its members, jointly and severally, make no guarantee, and assume no liability, in connection with any of this information. Moreover, it should not be assumed that every acceptable procedure is included, or that special circumstances may not warrant modified or additional procedure. The user should be aware that changing technology or regulations may require a change in the recommendations herein. Appropriate steps should be taken to insure that the information is current when used. These suggestions should not be confused with federal, state, provincial, municipal or insurance requirements, or with national safety codes.

1.4 APPROVAL

The Institute's Environmental Protection Committee approved the First Edition of this pamphlet on February 13, 1978.

1.5 REVISIONS

Suggestions for revisions should be directed to the Secretary of the Institute.

1.6 REPRODUCTION

The contents of this pamphlet are not to be copied for publication, in whole or in part, without prior Institute permission.

2. ASBESTOS USE IN CHLORINE MANUFACTURING

Most of the World's chlorine is produced by the electrolysis of brine in either mercury cells or diaphragm cells. In the electrolytic process, it is necessary to keep chlorine separated from the alkali metal hydroxide co-product to prevent chemical reaction. In addition, hydrogen produced with the alkali must be kept separated from the chlorine to prevent potentially violent explosions.

In mercury cells, separation is achieved by hydraulic seals which separate the chlorine and spent brine in the electrolyzer from the decomposer where the alkali metal hydroxide product and hydrogen are produced. No asbestos is involved.

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In diaphragm cells, separation is achieved by use of a diaphragm which is basically a porous mechanical barrier separating the anolyte and catholyte chambers. Brine is fed to the anolyte chamber where the chloride ion is electrolized to chlorine. The depleted brine and the cation percolate through the diaphragm to the cathode where hydrogen and alkali metal hydroxide are produced.

The key to successful operation of a diaphragm cell is the diaphragm material. To be suitable, it must have the following properties:

- sufficient mechanical strength;
- high chemical resistance;
- low electrical resistance;
- readily depositable on the cathode with uniform thickness and without voids;
- appropriate physical structure to permit percolation of depleted brine with minimum back-migration of hydroxyl ion; and
- acceptable service life.

These properties are of prime importance as they have a very significant effect on both capital and manufacturing costs. Asbestos is uniquely suitable as a diaphragm material, as it exhibits a most favorable combination of these properties.

Asbestos is a general term covering a group of impure, naturally occurring magnesium silicate minerals which exist in fibrous form. One of these is the mineral chrysotile which is made up of comparatively long and strong flexible fibers. It is a highly hydrated magnesium silicate of general composition, $Mg_6(OH)_8Si_4O_{10}$. Over 95% of the asbestos mined is chrysotile and it is the form used for diaphragms by the chlor-alkali industry.

A great deal of research has been done to study the behavior of asbestos in chlor-alkali cell environments to explain its unique behavior. The deposited fibers do not merely function as a deposited mat such as is found in a filter bed. The gel layer that forms in the mat under proper cell diaphragm depositing conditions plays an important role in the performance of the diaphragm, particularly in minimizing back-migration of the hydroxyl ion.

North American consumption of asbestos for chlor-alkali cells in 1978 is estimated to be in the order of 3,500 tons per year. Asbestos consumption per ton of chlorine produced has been significantly reduced over the years through advancements in cell design, improved brine purification techniques and new anode materials. Asbestos diaphragm life has been increased very significantly. The first major increase occurred with the change-over from carbon to graphite anodes. More recently the change to metal anodes has extended diaphragm life by some three to four fold compared to experience with graphite anodes. A newer development, resin bonding of the deposited asbestos fibers, is expected to increase the stability of asbestos diaphragms and further extend their life.

Asbestos is the universally accepted material for chlor-alkali cell diaphragms, and if handled properly, it can be used and disposed of safely both with respect to worker health and protection of the environment.

3. REGULATIONS

3.1 UNITED STATES

Currently in the U.S. regulations applicable to asbestos have been issued by the EPA, OSHA, DOT, Food and Drug Administration, the Consumer Product Safety Comission and the Mining Safety and Health Administration. Only the first two are of direct concern in the operation of chlor-alkali plants. States may also promulgate standards which can be more stringent than the Federal standards.

3.1.1 OSHA

The stated purpose of the OSH Act is to "assure so far as possible every working man and woman in the nation safe and healthful working conditions". OSHA's activities are the development, promulgation and enforcement of Federal safety and health standards; the development aspect is shared with NIOSH. The current OSHA asbestos standard was published in 37FR11318 (June 7, 1972) and is embodied in 29CFR1910.1001.

In summary, the standard:

* Establishes an eight-hour time-weighted average (TWA) worker exposure limit of airborne asbestos at two(2) fibers per cc of air longer than 5 micrometers. And, as a ceiling concentration, the regulation states that no employee shall be exposed at any time to asbestos concentrations in excess of 10 fibers per cc of air longer than 5 micrometers [29CFR1910.1001(b)(2) and (3)];
* Prescribes various methods of compliance, including engineering methods and controls such as isolation, exposure, dust collection and exhaust ventilation, and work practices including rules governing wat methods, handling of asbestos products etc. [29CFR1910.1001(c)(1) and (2)];
* Permits for purposes of compliance the use of work shift rotation (preferred) and respirators only in certain work situations. (See §5.1). The regulations further specify the type of respirators to be used under various conditions [29CFR1910.1001(d)(1) and (2)];
* Provides that employers shall provide and require the use of protective clothing for employees exposed to asbestos concentrations exceeding the prescribed ceiling level. [29CFR1910.1001(d)(3)].

*Prescribes that employers shall provide change rooms at any fixed place of employment exposed to airborne concentrations of asbestos fiber in excess of allowable exposure limits, and two separate lockers or containers for each employee to keep street clothes separate from work clothes. [29CFR1910.1001(d)(4)];

*Provides for the labeling, transport and laundering of asbestos contaminated clothing, including off-premises laundering [29CFR1910.1001(d)(4)(iii)];

*Establishes a method for measuring the airborne concentration of asbestos. (See §9.1) [29CFR1910.1001(e)];

*Establishes monitoring methods and frequency relating both to the work environment and individual employees, and requires that employees or their representatives be given a reasonable opportunity to observe the monitoring and to have access to monitoring records [29CFR1910.1001(f)];

*Prescribes rules for the posting of caution signs in areas where asbestos concentrations may exceed the allowable limits, and labels to be affixed on raw materials, mixtures, scrap, waste, debris or their containers [29CFR1910.1001(g)];

*Establishes certain housekeeping requirements including the cleaning of the work place and asbestos waste disposal [29CFR1910.1001(h)];

*Establishes certain recordkeeping requirements governing individual and environmental monitoring exposure records, employee access to exposure records, and employee notification of exposure to asbestos [29CFR1910.1001(i)].

*Requires preplacement, annual, and work termination medical examinations and the maintenance of, and employee access to, medical records [29CFR1910.1001 (j)].

3.1.2 EPA-Air

Emission standards on asbestos applicable specifically to the chlor-alkali industry were published by EPA in 38FR8820 (April 6, 1973) and amended 40FR48292 (October 14, 1975), as part of the Clean Air Act's §112 National Emission Standards for Hazardous Air Pollutants (NESHAP). They are embodied in 40CFR Part 61, Subpart B.

In summary, the standard:

*Provides that there shall be no visible emissions to the outside air (i.e. air outside buildings and structures) or directly from chlorine manufacturing operations if they are conducted outside of buildings or structures [40CFR61.22(c)]; or,

*Provides, at the owner/operator's option, use of specified methods to clean emissions containing particulate asbestos material before such emissions escape to, or are vented to, outside air [40CFR61.22(f) and 40CFR61.23];

*Requires asbestos waste generators to insure that the waste is disposed of in a properly operated disposal site [40CFR61.22(j) and 40CFR61.25];

*Establishes reporting requirements in connection with the handling of asbestos-containing waste materials [40CFR61.24].

3.1.3 EPA-Wastewater

PL 92-500, the Federal Water Pollution Control Act Amendments of 1972, as amended (PL 95-217), requires that industrial sources treat their effluent by applying the "best practicable control technology currently available" (BPT) by July 1, 1977. Effluent limitation guidelines establish the degree of effluent quality necessary to meet BPT limits. Though not specific for asbestos BPT total suspended solids limitations applicable both to existing and new diaphragm cell chlorine manufacturing operations are established [§415.62(b)] as follows:

Daily Maximum		30-day Average Maximum	
kg/1000 $kgCl_2$	lbs/1000 $lbsCl_2$	kg/1000 $kgCl_2$	lbs/1000 $lbsCl_2$
0.64	0.64	0.32	0.32

3.1.4 EPA-Hazardous Wastes

Regulations pursuant to Subtitle C of PL 94-580, the Resource Conservation and Recovery Act of 1976, have not yet been promulgated. Such regulations as do currently apply to the handling of asbestos-contaminated wastes are embodied in the NESHAP regulations discussed in §3.1.2.

3.1.5 DOT-Hazardous Materials

Regulations relative to commercial asbestos shipments were published by DOT in 43FR56664 (December 4, 1978). They are embodied in 49CFR, Parts 172 thru 177; see § 9.2.1.

3.2 CANADA

Canada is the Western world's largest producer of asbestos and supplies about 35 per cent of the global production. As is the case for U.S., both Federal and Provincial regulations are applicable.

3.2.1 Workplace

No Federal regulations have thusfar been promulgated. At the provincial level, the Quebec Draft Regulations dated February 1975 propose to reduce the present allowable level from 12 fibers/cc (all forms > 5 micrometers) to 5 fibers/cc. The workplace standard for the province of Ontario, however, is 2 fibers/cc.

3.2.2 Air

Federal Clean Air Act regulations for asbestos promulgated July 13, 1977 require that air emitted to the atmosphere from crushing, drying and milling operations and dry rock storage shall not contain more than 2 fibers/cc of air (fibers being >5 micrometers in length and having a length to width ratio of > 3).

3.2.3 Water

No Federal asbestos regulations have yet been promulgated but they are in process of development. At the Provincial level, it has been established with the Quebec Ministry of Environment that "Asbestos sludge must be prevented from entering the water course and can only be removed from the site after consultation with an Environmental Official".

4. CONTROL PROCEDURES

4.1 GENERAL

This pamphlet is limited to considerations relative only to asbestos safe handling and disposal practices applicable to the chlor-alkali industry. Examples of satisfactory asbestos control practices, where given, are intended to be only illustrative and are not to be construed either as having universal applicability or representing the only available or suitable means of control.

4.2 PURCHASING

While the handling of asbestos is presumed to start when a box car or truck is received at the plant, there are some earlier opportunities for minimizing later handling problems such as at the time of issuance of purchase orders. See §9.2.

It is recommended that purchase orders be written to the vendor which includes two items, namely; (1) palletizing of the asbestos bags in the rail car or truck, and (2) provision for a shrink-wrapped coating of Visceeper or other non-porous material covering the palleted bags. This procedure is especially effective in preventing torn bags and minimizing the threat of loose material during unloading. In addition, the palletized, shrink-wrapped packaging procedure allows ease of movement to the confinement areas.

In plants that do not have forklift unloading, it is suggested that asbestos shipments have sufficient dunnage included to prevent movement and damage to the bags during transport.

4.3 RECEIVING

Where asbestos is received in palletized form, whether by rail car or truck, the contents should be carefully inspected before the unloading operation begins. If broken bags or loose asbestos are in evidence at the time, a heavy duty vacuum cleaner should be used before the major work crew is called for the unloading operation. A heavy duty bag vacuum cleaner closely approximates the blower/bag system recommended by EPA for emission control. Broken bags should be enclosed in a heavy duty plastic bag before the vacuum clean up is started. That person charged with the initial inspection of the shipment should be equipped with an approved dust mask (§5.3) as well as wear suitable protective clothing (§5.4). If unsafe conditions exist all other individuals should be kept away from the area until such time as the condition is corrected.

When transporting palletized asbestos to storage, care should be taken to prevent puncturing the bags with the forks of the truck or damage by running into corners or loose objects. The plastic-wrapped pallet cover makes it possible to unload even during inclement weather, if desired. The operator of the fork truck should have available a dust mask and wear appropriate protective clothing if the situation warrants. An effort should be made to keep to a minimum the number of employees used for the unloading operation, while at the same time avoiding any safety risks. Contract labor used by the plant must be protected in the same manner as a permanent employee. Workable agreements between the company and the contractor, preferably in writing, should be clearly understood and adhered to at all times.

4.4 STORAGE

An important aspect of the total asbestos handling program is an appropriate storage area. All plants require an inventory of asbestos on hand for normal operations, and careful thought should be given to the storage area design.

Ideally the asbestos storage area should have no direct interconnection with the primary work area of the cell renewal operation. The entry should be sufficiently large to permit easy access of the forklift into the storage compound. The entry door should be equipped with a rubber gasket on the sealing lip to provide for a reasonably tight system. The ceiling should be as low as possible to limit unused space and at the same time provide the clearance height needed for pallet stacking. The approach to the storage area must be appropriately marked with a caution sign stipulated by OSHA regulations [29CFR19.1001(g)].

When an access way exists between the asbestos storage area and the major work area of a cell renewal operation it should have a well-fitted door with good weather stripping. The door should remain closed at all times and should be marked with an OSHA-approved caution sign. In such cases it is recommended that the storage area be maintained under a slight negative pressure.

Another means of storage is the "assigned" railroad car, if trackage is available near the operation area. This method not only insures improved condition of asbestos shipments but also decreases the amount of handling and the potential for spillage. The rail car must be properly marked with warning signs.

A first-in, first-out inventory system is recommended and, thus, if possible, the storage area should be designed and appropriately sized to accomodate this type of inventory control. The logic of a first-in first-out inventory control is simply that this control reduces problems associated with long term storage of asbestos bags.

The asbestos storage area should be kept clean and free of loose asbestos fiber. This can best be accomplished with a common sense approach to housekeeping. Wooden pallets should not be allowed to accumulate in the storage area. Any area or surface showing signs of asbestos, whether on floors, walls, or pallets, should be vacuumed using an appropriate industrial-type vacuum cleaner. The disposal of the vacuum cleaner bag must be handled in an environmentally sound manner such as by enclosing it in a labeled, heavy plastic type bag or other impervious

9.1.1 EPA Method for Asbestos in Water

PRELIMINARY INTERIM PROCEDURE

FOR

FIBROUS ASBESTOS

by

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July 31, 1976

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FIBROUS ASBESTOS

(Preliminary Interim Procedure)

(Transmission Electron Microscopy Method)

1. Scope and Application

1.1 This method is applicable to drinking water and water supplies.

1.2 The method determines the number of asbestos fibers/liter, their size (length and width), the size distribution, and total mass. The method distinguishes chrysotile from amphibole asbestos. The detection limits are variable and depend upon the amount of total extraneous particulate matter in the sample as well as the contamination level in the laboratory environment. Under favorable circumstances 0.1 MFL (million fibers per liter) can be detected. The detection limit for total mass of asbestos fibers is also variable and depends upon the fiber size and size distribution in addition to the factors affecting the total fiber count. The detection limit under favorable conditions is in the order of 0.1 ng/l.

1.3 The method is not intended to furnish a complete characterization of all the fibers in water.

1.4 It is beyond the scope of this method to furnish detailed instruction in electron microscopy, electron diffraction or crystallography. It is assumed that those using this method will be sufficiently knowledgeable in these fields to understand the methodology involved.

1.5 The method outlined below is based upon what is considered to be state-of-the art practice but it is emphasized that at present no single analytical procedure for asbestos is universally accepted. As a result no inter-laboratory comparisons are presented and the procedure should not be considered as a standard method.

2. Summary of Method

2.1 A variable, known volume of water sample is filtered through a membrane filter of sufficiently small pore size to trap asbestos fibers. A small portion of the filter with deposited fibers is placed on an electron microscope grid and the filter material removed by gentle solution in organic solvent. The material remaining on the electron microscope grid is examined

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in a transmission microscope at high magnification. The asbestos fibers are identified by their morphology and electron diffraction pattern and their length and width are measured. The total area examined in the electron microscope is determined and the number of asbestos fibers in this area is counted. The concentration in MFL (millions of fibers/liter) is calculated from the number of fibers counted, the amount of water filtered, and the ratio of the total filtered area/sampled filter area. The mass/liter is calculated from the assumed density and the volume of the fibers.

3. Definitions

Asbestos - A generic term applied to a variety of commercially useful silicate minerals that may have a fibrous structure.

Fiber - Any particle that has parallel sides and a length/width ratio greater than or equal to 3:1.

Aspect Ratio - The ratio of length to width.

Chrysotile - A nearly pure hydrated magnesium silicate, the fibrous form of the mineral serpentine, possessing a unique layered structure in which the layers are wrapped in a helical cylindrical manner about the fiber axis.

Amphibole - A silicate mineral whose basic structural unit is a double silica chain (Si_4O_{11}), but with a variable composition and a layered structure that is easily cleaved to form a fiber.

Detection Limit - The calculated concentration in MFL, equivalent to one fiber above the background or blank count.

Statistically Significant - Any concentration based upon a total fiber count of five or more in 20 grid squares.

4. Sample Handling and Preservation

4.A Sampling

It is beyond the scope of this procedure to furnish detailed instructions for field sampling; the general principles of sampling waters are applicable. There are some considerations that apply to asbestos fibers, a special type of particulate matter. These fibers are small, and in water range in length from .1 µm to 20 µm or more. Because of the range of size there may be a vertical distribution of particle sizes. This distribution will vary with depth depending upon the vertical distribution of temperature as well as the local meteorological conditions. Sampling should take place according to the objective of the analysis. If a representative sample of a water supply is required a carefully designed set of samples should be taken representing the vertical as well as the horizontal distribution and these samples composited for analysis.

4.1 Containment Vessel

The sampling container shall be a clean polyethylene, screw-capped bottle capable of holding at least one liter. The bottle should be rinsed at least two times with the water that is being sampled prior to sampling.

NOTE: Glass vessels are not suitable as sampling containers.

4.2 Quantity of Sample

A minimum of approximately one liter of water is required and the sampling container should not be filled. It is desirable to obtain two samples from one location.

4.3 Sample Preservation

No preservatives should be added during sampling and the addition of acids should be particularly avoided. If the sample cannot be filtered in the laboratory within 48 hours of its arrival, sufficient amounts (1 ml/l of sample) of a 2.7% solution of mercuric chloride to give a final concentration of 20 ppm of Hg may be added to prevent bacterial growth.

5. Interferences

5.1 Misidentification

The guidelines set forth in this method for counting fibrous asbestos require a positive identification by both morphology and crystal structure as shown by an electron diffraction pattern. Chrysotile asbestos has a unique tubular structure, usually showing the presence of a central canal, and exhibits a unique characteristic electron diffraction pattern. Although halloysite fibers may show a similar streaking to chrysotile they do not exhibit its characteristic triple set of double spots or 5.3A layer line. It is highly improbable that a non-asbestiform fiber would exhibit the distinguishing chrysotile features. Although amphibole fibers exhibit characteristic morphology and electron diffraction patterns, they do

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not have the unique properties exhibited by chrysotile. It is therefore possible though not probable for misidentification to take place. Hornblende is an amphibole and, in a fibrous form, will be mistakenly identified as amphibole asbestos.

It is important to recognize that a significant variable fraction of both chrysotile and amphibole asbestos fibers do not exhibit the required confirmatory electron diffraction pattern. This absence of diffraction is attributable to unfavorable fiber orientation and fiber sizes. The results reported will therefore be low as compared to the absolute number of asbestos fibers that are present.

5.2 Obscuration

If there are large amounts of organic or amorphous inorganic materials present, some small asbestos fibers may not be observed because of physical overlapping or complete obscuration. This will result in low values for the reported asbestos content.

5.3 Contamination

Although contamination is not strictly considered an interference, it is an important source of erroneous results, particularly for chrysotile. The possibility of contamination should therefore always be a consideration.

5.4 Freezing

The effect of freezing on asbestos fibers is not known but there is reason to suspect that fiber break down could occur and result in a higher fiber content than was present in the original sample. Therefore the sample should be transported to the laboratory under conditions that would avoid freezing.

6. Equipment and Apparatus

6.1 Specimen Preparation Laboratory

The ubiquitous nature of asbestos, especially chrysotile, demands that all sample preparation steps be carried out to prevent the contamination of the sample by air-borne or other source of asbestos. The prime requirement of the sample preparation laboratory is that it be sufficiently free from asbestos contamination that a specimen blank determination using 200 ml of asbestos-free water yields no more than 2 fibers in twenty grid squares of a conventional 200 mesh electron microscope grid.

In order to achieve this low level of contamination, the sample preparation area should be a separate conventional clean room facility. The room should be operated under positive pressure and have incorporated electrostatic precipitators in the air supply to the room, or alternatively absolute (HEPA) filters. There should be no asbestos floor or ceiling tiles, transite heat-resistant boards, nor asbestos insulation. Work surfaces should be stainless steel or Formica or equivalent. A laminar flow hood should be provided for sample manipulation. Disposable plastic lab coats and disposable overshoes are recommended. Alternately new shoes for all operators should be provided and retained for clean room use only. A mat (Tacky Mat, Liberty Industries, 589 Deming Rd., Berlin, Connecticut 06037, or equivalent) should be placed inside the entrance to the room to trap any gross contamination inadvertently brought into the room from contaminated shoes. Normal electrical and water services, including a distilled water supply should be provided. In addition a source of ultra-pure water from a still or filtration-ion exchange system is desirable.

6.2 Instrumentation

6.2.1 Transmission Electron Microscope. A transmission electron microscope that operates at a minimum of 80 KV, has a resolution of 1.0 nm and a magnification range of 300 to 100,000. If the upper limit is not attainable directly it may be attained through the use of auxiliary optical viewing. It is mandatory that the instrument be capable of carrying out selected area electron diffraction (SAED) on an area of 300 nm. The viewing screen shall have either a millimeter scale, concentric circles of known radii, or other devices to measure the length and width of the fiber. Most modern transmission microscopes meet the requirements for magnification and resolution.

An energy-dispersive X-ray spectrometer is useful for the identification of suspected asbestiform minerals; this accessory to the microscope, however, is not mandatory.

6.2.2 Data Processor. The large number of repetitive calculations make it convenient to use computer facilities together with relatively simple computer programs.

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6.2.3 Vacuum Evaporator. For depositing a layer of carbon on the Nuclepore filte and for preparing carbon coated grids.

6.2.4 Low Temperature Plasma Asher. To be used for the removal of organic material (including the fil) from samples containing so much org ic matter that asbestos fibers are obscured. The sample chamber should at least 10-cm diameter.

6.3 Apparatus, Supplies and Reagents

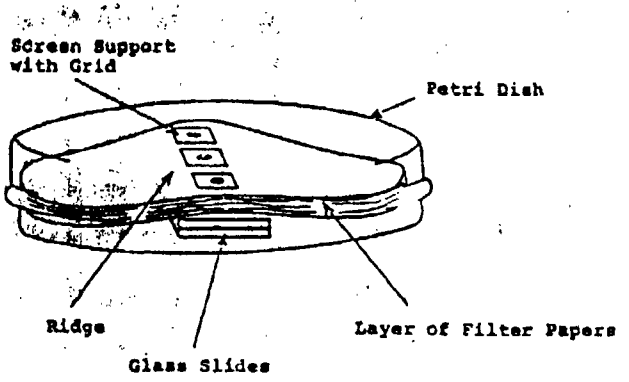
6.3.1 Jaffe Wick Washer. For dissolving Nuclepore filter (if Nuclepore is used in sample preparation). Assemble as in 8.2A.1. It is illustrated in Figure 1.

6.3.2 Condensation Washer. For use in dissolving the Millipore filter when using the Millipore sample preparation method. A system with controlled heating, controlled refluxing, and a cold finger for holding the electron microscope (EM) sample grids. At least two systems are commercially available. Figure 2 is an illustration of one design that has proven satisfactory.

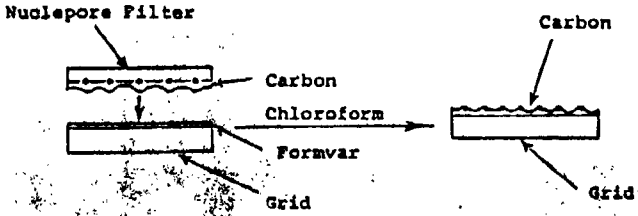
6.3.3 Filtering Apparatus. 47-mm funnel (Cat. No. XX1504700, Millipore Corporation, Order Service Dept., Bedford, MA 01730). Used to filter water samples. 25-mm funnel (Millipore Cat. No. XX1002500). Used to filter dispersed ash samples.

6.3.4 Vacuum Pump. For use in sample filtration. Should provide vacuum up to 20 inches of mercury.

6.3.5 EM Grids. 200-mesh copper or nickel grids covered with carbon-coated collodion for use with the Millipore-condensation washing technique. Formvar-backed grids, without a carbon coating are used in the Nuclepore-Jaffe sample preparation method. These grids may be purchased from manufacturers of electron microscopic supplies or prepared by standard electron microscopic grid preparation procedures. Finder grids may be substituted and are useful if the re-examination of a specific grid opening is desired.



A.



B.

Figure 1. Modified Jaffe Wick Method
A. Washing Apparatus
B. Washing Process

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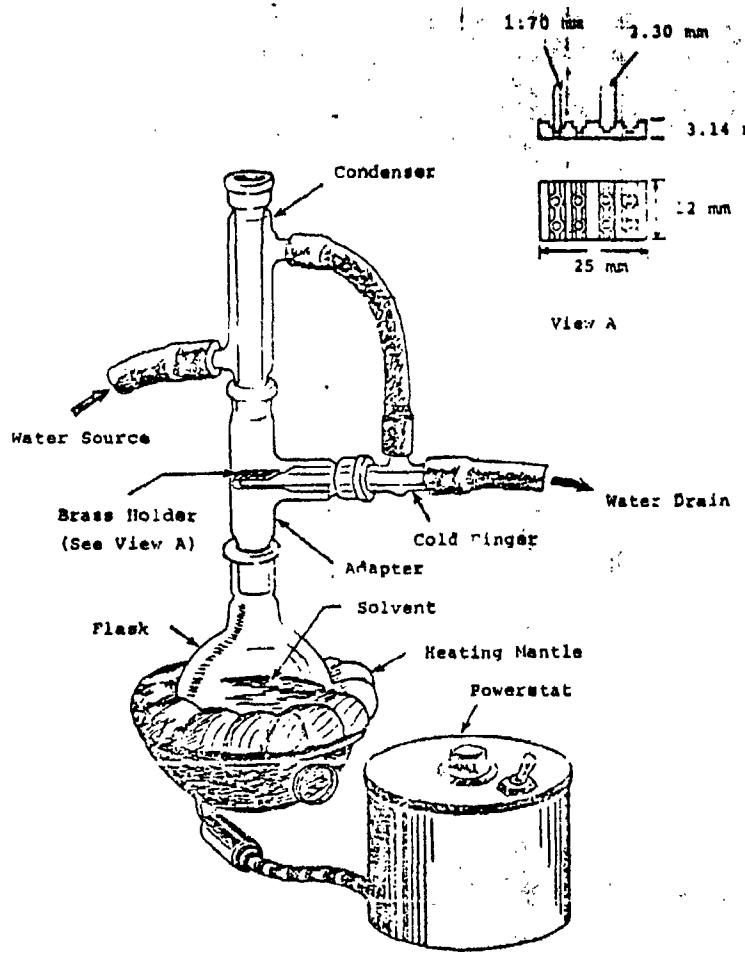

Figure 2. Condensation Washer

6.3.6 **Membrane Filters.**

47-mm diameter Millipore membrane filter, type HA; 0.45 µm pore size. For filtration of water sample.

47-mm diameter Nuclepore membrane filter; 0.1 µm pore size. (Nuclepore Corp, 7035 Commerce Circle, Pleasanton, CA 94566) For filtration of water sample.

47-mm diameter Millipore membrane filter type BS; 2 µm pore size. Used as a Nuclepore filter support on top of the glass frit.

25-mm diameter Millipore membrane filter, type HA; 0.45 µm pore size. To filter dispersed ashed Millipore filter.

25-mm diameter Nuclepore membrane filter; 0.1 µm pore size. To filter dispersed ashed Millipore filter.

25-mm diameter Millipore membrane filter, type BS; 2.0 µm pore size. To be used as a Nuclepore filter support on top of the glass frit.

6.3.7 **Glass Vials. 30-mm diameter x 80-mm long. For holding filter during ashing.**

6.3.8 **Glass Slides. 5.1-cm x 7.5-cm. For support of Nuclepore filter during carbon evaporation.**

6.3.9 **Scalpels. With disposable blades and scissors.**

6.3.10 **Tweezers. Several pairs for the many handling operations.**

6.3.11 **"Scotch" Doublestick tape. To hold filter section flat on glass slide while carbon coating.**

6.3.12 **Disposable Petri dishes, 50-mm diameter, for storing membrane filters.**

6.3.13 **Static Eliminator, 500 microcuries Po-210. (Nuclepore Cat. No. V090P0L001011 or equivalent. To eliminate static charges from membrane filters.**

6.3.14 **Carbon rods, spectrochemically pure, 1/8" dia., 3.6 mm x 1.0 mm neck. For carbon coating.**

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6.3.15 Carbon rod sharpener. (Cat. No. 1104, Ernest F. Fullam, Inc., P. O. Box 848, Schenectady, NY 12301) For sharpening carbon rods to a neck of specified length and diameter.

6.3.16 Ultrasonic Bath. (50 watts, 55 KHz) For dispersing ashed sample and for general cleaning.

6.3.17 Graduated Cylinder, 500 ml.

6.3.18 Spot plate.

6.3.19 10 µl Microsyringe. For administering drop of solvent to filter section during sample preparation.

6.3.20 Carbon grating replica, 2160 lines/mm. For calibration of EM magnification.

6.3.21 Cork borer (1/8 inch diameter). For sampling prepared Millipore filters.

6.3.22 Filter paper, S & S #589 Black Ribbon or equivalent (9-cm circles). For preparing Jaffe Wick Washer.

6.3.23 Screen supports (copper or stainless steel) 12 mm x 12 mm, 200 mesh. To support specimen grid in Jaffe Wick Washer.

6.3.24 Brass holder. For holding specimen in condensation washer. See Figure 1, Item #12.

6.3.25 Chloroform, spectro grade, doubly distilled. For dissolving Nuclepore filters.

6.3.26 Acetone, reagent grade or better. For dissolving Millipore filters.

6.3.27 Asbestos, Chrysotile (Canadian), Crocidolite, Amosite. UICC (Union Internationale Contre le Cancer) Standards. Available from Duke Standards Company, 445 Sherman Avenue, Palo Alto, CA 94306.

6.3.28 Petri dish, glass (100 mm diameter x 15 mm high). For modified Jaffe Wick Washer.

6.3.29 Alconox. (Alconox, Inc., New York, NY 10003) For cleaning glassware. Add 7.5 g Alconox to a liter of distilled water.

6.3.30 Aerosol OT, 0.1% solution (Cat. No. So-A-292, Fisher Scientific Company, 711 Forbes Avenue, Pittsburgh, PA 15219) Used as dispersion medium for ashed Millipore filter. Prepare a 0.1% solution by diluting 1 ml of the 10% solution to 100 ml with distilled water. Filter through 0.1-µm Nuclepore filter paper before using.

6.3.31 Parafilm. (American Can Company, Neenah, WI) Used as protective covering for clean glassware.

6.3.32 Pipets, disposable, 5 ml and 50 ml.

6.3.33 Distilled or deionized water. Filter through 0.1-µm Nuclepore filter for making up all reagents and for final rinsing of glassware, and for preparing blanks.

6.3.34 Mercuric chloride, 2.71% solution w/v. Used as sample preservative. See 4.3. Add 5.42 g of reagent grade mercuric chloride ($HgCl_2$) to 100 ml distilled water and dissolve by shaking. Dilute to 200 ml with additional water. Filter through 0.1-µm Nuclepore filter paper before using.

7. Preparation of Standards

Reference standard samples of asbestos that can be used for quality control of a quantitative analytical method are not available. It is, however, necessary for each laboratory to prepare at least one suspension of chrysotile and another of a representative amphibole. These suspensions can then be used for intra-laboratory control and furnish standard morphology photographs and diffraction patterns.

7.1 Chrysotile Stock Solution.

Grind about 0.1 g of UICC chrysotile in an agate mortar for several minutes, or until it appears to be a powder. Weigh out 10 mg and transfer to a clean 1 liter volumetric flask, add several hundred ml of millipore filtered distilled water containing 0.1 percent Aerosol OT and one ml of a 20,000 ppm solution of mercury and then make up to 1 liter with the 0.1 percent Aerosol filtered distilled water. To prepare a working solution, transfer 10 ml of the above suspension to another 1-liter flask, add 1 ml of a 20,000 ppm solution of mercury and make up to 1 liter with the same 0.1 percent aerosol OT solution. This suspension contains 100 µg per liter. Finally transfer 1 ml of this suspension to a 1-liter flask.

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add 1 ml of a 20,000 ppm solution of mercury and make up to volume with the 0.1 percent aerosol OT solution. The final suspension will contain 5-10 MFL and is suitable for laboratory testing.

7.2 Amphibole Stock Dispersion.

Prepare amphibole suspensions from UICC amphibole samples as in Section 7.1.

7.3 Identification Standards

Prepare electron microscopic grids containing the UICC asbestos fibers according to 8, Procedure, and obtain representative photographs of each fiber type and its diffraction pattern for future reference.

8. Procedure

8.1 Filtration.

The separation of the insoluble material, including asbestiform minerals, through filtration and subsequent deposition on a membrane filter is a very critical step in the procedure. The objective of the filtration is not only to separate but also to distribute uniformly the particulate matter such that discreet particles are deposited with a minimum of overlap.

The volume filtered will range from 50-500 ml. In an unknown sample the volume can not be specified in advance because of the presence of variable amounts of particulate matter. In general sufficient sample is filtered such that a very faint stain can be observed on the filter medium. The maximum loading that can be tolerated is 20 $\mu g/cm^2$, or about 200 μg on a 47-mm diameter filter; 5 $\mu g/cm^2$ is near optimum. If the total solids content is known, an estimate of the maximum volume tolerable can be obtained. In a sample of high solids content, where less than 50 ml is required, the sample should be diluted with filtered distilled water so that a minimum total of 50 ml of water is filtered. This step is necessary to allow the insoluble material to deposit uniformly on the filter. The filtration funnel assembly must be scrupulously clean and cleaned before each filtration. The filtration should be carried out in a laminar flow hood.

NOTE 1: The following cleaning procedure has been found to be satisfactory:

Wash each piece of glassware three times with distilled water. Following manufacturer's recommendations use the ultrasonic bath with an Alconox-water solution to clean all glassware. After the ultrasonic cleaning rinse each piece of glassware three times with distilled water. Then rinse each piece three times with deionized water which has been filtered through 0.1-um Nuclepore filter. Dry in an asbestos-free oven. After the glassware is dry, seal openings with parafilm.

8.1.1 Filtration

a. Assemble the vacuum filtration apparatus incorporating either the .1-um Nuclepore backed with 2-um Millipore, or the .45-um Millipore filter. See 8.2A.2 or 8.2B.2.

b. Vigorously agitate the water sample in its container.

c. If the required filtration volume can be estimated, either from turbidity estimates of suspended solids or previous experience, immediately withdraw the proper volume from the container and add the entire volume to the 47-mm diameter funnel. Apply vacuum sufficient for filtration but gentle enough to avoid the formation of a vortex. If a completely unknown sample is being analyzed, a slightly modified procedure must be followed. Pour 500 ml of a well-mixed sample into a 500 ml graduated cylinder and immediately transfer the entire contents to the prepared vacuum filtration apparatus. Apply vacuum gently and continue suction until all of the water has passed through the filter. If the resulting filter appears obviously coated or discolored, it is recommended that another filter be prepared in the same manner, but this time using only 200 or 100 ml of sample.

NOTE 1: Do not add more water after filtration has started and do not rinse the sides of the funnel.

d. Disassemble the funnel, remove the filter and dry in a covered petri dish.

8.2 Preparation of Electron Microscope Grids.

The preparation of the grid for examination in the microscope is a critical step in the analytical procedure. The objective is to remove the organic

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filter material from the asbestos fibers with a minimum loss and movement and with a minimum breakage of the grid support film. Two alternative procedures are acceptable:

A. Nuclepore Filter, Modified Jaffe Wick

B. Millipore Filter, Condensation Washer

If the sample contains organic matter in such amounts that interfere with fiber counting and identification a preliminary ashing step is required. See 8.5.

NOTE 1: Two alternatives for grid preparation are suggested because the superiority of one technique over the other has not been substantiated by sufficient experimental evidence. The differences between the two techniques of sample preparation lie in the filtering medium (Nuclepore vs. Millipore), whether the filter is carbon coated, and in the method of dissolving the filter material. There is evidence that the condensation washing procedure can lose amphibole fibers and that amphiboles are more susceptible to loss than chrysotile.

8.2A Nuclepore Filter, Modified Jaffe Wick Technique.

8.2A.1 Preparation of Modified Jaffe Washer

Place three glass microscope slides (75 mm x [illegible] mm) one on top of the other in a petri dish (100 mm x 15 mm) along a diameter. Place 14 [illegible] 6589 Black Ribbon filter papers ([illegible] circles) in the petri dish over the stack of microscope slides. Place three mesh copper screen supports (12 mm x 12 mm) along the ridge formed by the stack of slides underneath the layer of filter papers. Place an EM specimen grid on each of the screen supports. See Fig. 1.

8.2A.2 Vacuum Filtration Unit

Assemble the vacuum filtration unit. Place a 2-µm Millipore filter type BS on the glass frit and then position a 0.1-µm Nuclepore filter, shiny side up, on top of the Millipore filter. Apply suction to center the filters flat on the frit. Attach the filter funnel and shut off the suction.

8.2A.3 Sample Filtration

See 8.1.1.

8.2A.4 Sample Drying

Remove the filter funnel and place the Nuclepore filter in a loosely covered petri dish to dry. The petri dish containing the filter may be placed in an asbestos-free oven at 45° C for 30 minutes to shorten the drying time.

8.2A.5 Selection of section for carbon coating

Using a small pair of scissors or sharp scalpel cut out a retangular section of the Nuclepore filter. The minimum approximate dimensions should be 15 mm long and 3 mm wide. Avoid selection near the perimeter of the filtration area.

8.2A.6 Carbon Coating the Filter

Tape the two ends of the selected filter section to a glass slide using "Scotch" tape. Take care not to stretch the filter section. Identify the filter section using a china marker on the slide. Place the glass slide with the filter section into the vacuum evaporator. Insert the necked carbon rod and, following manufacturer's instructions, obtain high vacuum. Evaporate the neck, with the filter section rotating, at a distance of approximately [illegible] from the filter section to obtain a [illegible] layer of carbon on the filter paper. Evaporate the carbon in several short bursts rather than continuously to prevent overheating the surface of the Nuclepore filter.

NOTE 1: Overheating the surface tends to crosslink the plastic, rendering the filter dissolution in chloroform difficult.

NOTE 2: The thickness of the carbon film can be monitored by placing a drop of oil on a porcelain chip that is placed at the same distance from the carbon electrodes as the specimen. Carbon is not visible in the region of the oil drop thereby enabling a visual estimate of the deposit thickness by the contrast differential.

8.2A.7 Grid Transfer

Remove the filter from the vacuum evaporator and cut out three sections somewhat less than

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PART 172—HAZARDOUS MATERIALS TABLE AND HAZARDOUS MATERIALS COMMUNICATIONS REGULATIONS

1. In § 172.101 the Hazardous Materials Table is amended by adding a new entry, immediately following "Arsine," to read as follows:

§ 172.101 Hazardous materials table.

(1)	(2) Hazardous materials descriptions and proper shipping name	(3) Hazard class	(4) Labels(s) required (if not excepted)	(5) Packaging: (a) Exception	(5) Packaging: (b) Specific requirements	(6) Maximum net quantity in one package: (a) Passenger carrying aircraft or railcar	(6) Maximum net quantity in one package: (b) Cargo only aircraft	(7) Water shipments: (a) Cargo vessel	(7) Water shipments: (b) Passenger vessel	(8) Other requirement
*	(Add) Asbestos	ORM-C	None	173.1090 (c)	173.1090 (d)	No Limit	No Limit	1, 2	1, 2	Stow and handle to avoid airborne particles.

PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS

2. Section 173.1090 is added preceding Subpart N to read as follows:

§ 173.1090 Asbestos.

(a) Asbestos includes any of the following hydrated mineral silicates: chrysotile, crocidolite, amosite, anthophyllite asbestos, tremolite asbestos, actinolite asbestos, and every product containing any of these minerals.

(b) Commercial asbestos is any material or product containing asbestos that has commercial value because of its asbestos content.

(c) Asbestos which is immersed or fixed in a natural or artificial binder material (such as cement, plastic, asphalt, resins or mineral ore) and manufactured products containing asbestos or any materials or products whose commercial value is not dependent on their asbestos content, are not subject to the requirements of this subchapter.

(d) Commercial asbestos must be offered for transportation and transported in—

(1) Rigid, airtight packagings such as metal or fiber drums, portable tanks, or

(2) Bags and other non-rigid packagings that are dust and sift proof. When transported by other than a private carrier by highway, bags and other non-rigid packagings containing asbestos must be palletized and unitized by methods such as shrink-wrapping in plastic film or wrapping in fiberboard secured by strapping.

PART 174—CARRIAGE BY RAIL

3. A Subpart M Heading is added immediately following § 174.812 to read as follows:

Subpart M—Detailed Requirements for Other Regulated Materials

4. Section 174.840 is added to read as follows:

§ 174.840 Special loading and handling requirements for asbestos.

Asbestos must be loaded, handled, and unloaded, and any asbestos contamination of rail cars removed, in a manner that will minimize occupational exposure to airborne asbestos particles released incident to transportation. (See § 173.1090 of this subchapter.)

PART 175—CARRIAGE BY AIRCRAFT

5. Section 175.640 is added to read as follows:

§ 175.640 Special requirements for other regulated materials.

Asbestos must be loaded, handled, and unloaded, and any asbestos contamination of aircraft removed, in a manner that will minimize occupational exposure to airborne asbestos particles released incident to transportation. (See § 173.1090 of this subchapter.)

PART 176—CARRIAGE BY VESSEL

6. Section 176.906 is added to read as follows:

§ 176.906 Stowage and handling of asbestos.

Asbestos must be stowed, handled, and unloaded, and any asbestos contamination of vessels removed, in a manner that will minimize occupational exposure to airborne asbestos particles released incident to transportation. (See § 173.1090 of this subchapter.)

PART 177—CARRIAGE BY PUBLIC HIGHWAY

7. Section 177.844 is added to read as follows:

§ 177.844 Other regulated materials.

Asbestos must be loaded, handled, and unloaded, and any asbestos contamination of transport vehicles removed, in a manner that will minimize occupational exposure to airborne asbestos particles released incident to transportation. (See § 173.1090 of this subchapter.)

NOTE: These 49CFR Regs. are effective April 30, 1979.

9.2.2 EPA Regulations

40 CFR Part 61

Subpart B—National Emission Standard for Asbestos

§ 61.20 Applicability.

The provisions of this subpart are applicable to those sources specified in § 61.22.

§ 61.21 Definitions.

Terms used in this subpart are defined in the act, in Subpart A of this part, or in this section as follows:

(a) "Asbestos" means actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite.

(b) "Asbestos material" means asbestos or any material containing asbestos.

(c) "Particulate asbestos material" means finely divided particles of asbestos material.

(d) "Asbestos tailings" means any solid waste product of asbestos mining or milling operations which contains asbestos.

(e) "Outside air" means the air outside buildings and structures.

(f) "Visible emissions" means any emissions which are visually detectable without the aid of instruments and which contain particulate asbestos material.

(g) "Asbestos mill" means any facility engaged in the conversion or any intermediate step in the conversion of asbestos ore into commercial asbestos. Outside storage of asbestos materials is not considered a part of such facility.

(h) "Commercial asbestos" means any variety of asbestos which is produced by extracting asbestos from asbestos ore.

(i) "Manufacturing" means the combining of commercial asbestos, or in the case of woven friction products the combining of textiles containing commercial asbestos, with any other material(s), including commercial asbestos, and the processing of this combination into a product as specified in § 61.22(c).

(j) "Demolition" means the wrecking or taking out of any load-supporting structural member and any related removing or stripping of friable asbestos materials.

(k) "Friable asbestos material" means any material that contains more than 1 percent asbestos by weight and that can be crumbled, pulverized, or reduced to powder, when dry, by hand pressure.

(l) "Control device asbestos waste" means any asbestos-containing waste material that is collected in a pollution control device.

(m) "Renovation" means the removing or stripping of friable asbestos material used to insulate or fireproof any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member. Operations in which load-supporting structural members are wrecked or taken out are excluded.

(n) "Planned renovation" means a renovation operation, or a number of such operations, in which the amount of friable asbestos material that will be removed or stripped within a given period of time can be predicted. Operations that are individually non-scheduled are included, provided a number of such operations can be predicted to occur during a given period of time based on operating experience.

(o) "Emergency renovation" means a renovation operation that results from a sudden, unexpected event, and is not a planned renovation. Operations necessitated by non-routine failures of equipment are included.

(p) "Adequately wetted" means sufficiently mixed or coated with water or an aqueous solution to prevent dust emissions.

(q) "Removing" means taking out friable asbestos materials used to insulate or fireproof any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member from any building, structure, facility, or installation.

(r) "Stripping" means taking off friable asbestos materials used for insulation or fireproofing from any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member.

(s) "Fabricating" means any processing of a manufactured product containing commercial asbestos, with the exception of processing at temporary sites for the construction or restoration of buildings, structures, facilities or installations.

(t) "Inactive waste disposal site" means any disposal site or portion thereof where additional asbestos-containing waste material will not be deposited and where the surface is not disturbed by vehicular traffic.

(u) "Active waste disposal site" means any disposal site other than an inactive site.

(v) "Roadways" means surfaces on which motor vehicles travel including, but not limited to, highways, roads, streets, parking areas, and driveways.

(w) "Asbestos-containing waste material" means any waste which contains commercial asbestos and is generated by a source subject to the provisions of this subpart, including asbestos mill tailings, control device asbestos waste, friable asbestos waste material, and bags or containers that previously contained commercial asbestos.

(x) "Structural member" means any load-supporting member, such as beams and load-supporting walls; or any non-load-supporting member, such as ceilings and non-load-supporting walls.

[38 FR 8826, Apr. 6, 1973, as amended at 39 FR 15398, May 3, 1974; 40 FR 48299, Oct. 14 1975; 42 FR 12127, Mar. 2, 1977]

§ 61.22 Emission standard.

(a) Asbestos mills: There shall be no visible emissions to the outside air from any asbestos mill except as provided in paragraph (f) of this section.

(b) Roadways: The surfacing of roadways with asbestos tailings or with asbestos-containing waste that is generated by any source subject to paragraphs (c), (d), (e) or (h) of this section is prohibited, except for temporary roadways on an area of asbestos ore deposits. The deposition of asbestos tailings or asbestos-containing waste on roadways covered with snow or ice is considered "surfacing."

(c) Manufacturing: There shall be no visible emissions to the outside air, except as provided in paragraph (f) of this section, from any of the following operations if they use commercial asbestos or from any building or structure in which such operations are conducted.

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine.

(10) The manufacture of shotgun shells.

(11) The manufacture of asphalt concrete.

(d) Demolition and renovation: The requirements of this paragraph shall apply to any owner or operator of a demolition or renovation operation who intends to demolish any institutional, commercial, or industrial building (including apartment buildings having more than four dwelling units), structure, facility, installation, or portion thereof which contains any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that is insulated or fireproofed with friable asbestos material, except as provided in paragraph (d)(1) of this section; or who intends to renovate any institutional, commercial, or industrial building, structure, facility, installation, or portion thereof where more than 80 meters (ca. 260 feet) of pipe insulated or fireproofed with friable asbestos material are stripped or removed, or more than 15 square meters (ca. 160 square feet) of friable asbestos material used to insulate or fireproof any duct, boiler, tank, reactor, turbine, furnace, or structural member are stripped or removed.

(1)(i) The owner or operator of a demolition operation is exempted from the requirements of this paragraph provided, (a) the amount of friable asbestos material in the building or portion thereof to be demolished is less than 80 meters (ca. 260 feet) used to insulate pipes, and less than 15 square meters (ca. 160 square feet) used to insulate or fireproof any duct, boiler, tank, reactor, tur-

oine, furnace, or structural member, and (b) the notification requirements of paragraph (d)(1)(ii) are met.

(ii) Written notification shall be postmarked or delivered to the Administrator at least 20 days prior to commencement of demolition and shall include the information required by paragraph (d)(2) of this section, with the exception of the information required by paragraphs (d)(2)(iii), (vi), (vii), (viii), and (ix), and shall state the measured or estimated amount of friable asbestos material used for insulation and fireproofing which is present. Techniques of estimation shall be explained.

(2) Written notice of intention to demolish or renovate shall be provided to the Administrator by the owner or operator of the demolition or renovation operation. Such notice shall be postmarked or delivered to the Administrator at least 10 days prior to commencement of demolition, or as early as possible prior to commencement of emergency demolition subject to paragraph (d)(6) of this section, and as early as possible prior to commencement of renovation. Such notice shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Description of the building, structure, facility, or installation to be demolished or renovated, including the size, age, and prior use of the structure, and the approximate amount of friable asbestos material used for insulation and fireproofing.

(iv) Address or location of the building, structure, facility, or installation.

(v) Scheduled starting and completion dates of demolition or renovation.

(vi) Nature of planned demolition or renovation and method(s) to be employed.

(vii) Procedures to be employed to meet the requirements of this paragraph and paragraph (j) of this section.

(viii) The name and address or location of the waste disposal site where the friable asbestos waste will be deposited.

(ix) Name, title, and authority of the State or local governmental representative who has ordered a demolition which is subject to paragraph (d)(6) of this section.

(3)(i) For purposes of determining whether a planned renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be:

(A) For planned renovating operations involving individually non-scheduled operations, the additive amount of friable asbestos material that can be predicted will be removed or stripped at a source over the maximum period of time for which a prediction can be made. The period shall be not less than 30 days and not longer than one year.

(B) For each planned renovating operation not covered by paragraph (d)(3)(i)(A), the total amount of friable asbestos material that can be predicted will be removed or stripped at a source.

(ii) For purposes of determining whether an emergency renovating operation constitutes a renovation within the meaning of this paragraph, the amount of friable asbestos material to be removed or stripped shall be the total amount of friable asbestos material that will be removed or stripped as a result of the sudden, unexpected event that necessitated the renovation.

(4) The following procedures shall be used to prevent emissions of particulate asbestos material to outside air:

(i) Friable asbestos materials, used to insulate or fireproof any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member, shall be removed from any building, structure, facility or installation subject to this paragraph. Such removal shall occur before wrecking or dismantling of any portion of such building, structure, facility, or installation that would break up the friable asbestos materials and before wrecking or dismantling of any other portion of such building, structure, facility, or installation that would preclude access to such materials for subsequent removal. Removal of friable asbestos materials used for insulation or fireproofing of any pipe, duct, or structural member which are encased in concrete or other similar structural material is not required prior to demolition, but such material shall be adequately wetted whenever exposed during demolition.

(ii) Friable asbestos materials used to insulate or fireproof pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall be adequately wetted during stripping, except as provided in paragraphs (d)(4)(iv), (d)(4)(vi) or (d)(4)(vii) of this section.

(iii) Pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members that are insulated or fireproofed with friable asbestos materials may be taken out of any building, structure, facility, or installation subject to this paragraph as units or in sections provided the friable asbestos materials exposed during cutting or disjointing are adequately wetted during the cutting or disjointing operation. Such units shall not be dropped or thrown to the ground, but shall be carefully lowered to ground level.

(iv) The stripping of friable asbestos materials used to insulate or fireproof any pipe, duct, boiler, tank, reactor, turbine, furnace, or structural member that has been removed as a unit or in sections as provided in paragraph (d)(4)(iii) of this section shall be performed in accordance with paragraph (d)(4)(ii) of this section. Rather than comply with the wetting requirement, a local exhaust ventilation and collection system may be used to prevent emissions to the outside air. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping of friable asbestos material. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems except as provided in paragraph (f) of this section.

(v) All friable asbestos materials that have been removed or stripped shall be adequately wetted to ensure that such materials remain wet during all remaining stages of demolition or renovation and related handling operations. Such materials shall not be dropped or thrown to the ground or a lower floor. Such materials that have been removed or stripped more than 50 feet above ground level, except those materials removed as units or in sections, shall be transported to the ground via dust-tight chutes or containers.

(vi) Except as specified below, the wetting requirements of this paragraph are suspended when the temperature at the point of wetting is below 0°C (32°F). When friable asbestos materials are not wetted due to freezing temperatures, such materials on pipes, ducts, boilers, tanks, reactors, turbines, furnaces, or structural members shall, to the maximum extent possible, be removed as units or in sections prior to wrecking. In no case shall the requirements of paragraphs (d)(4)(iv) or (d)(4)(v) be suspended due to freezing temperatures.

(vii) For renovation operations, local exhaust ventilation and collection systems may be used, instead of wetting as specified in paragraph (d)(4)(ii), to prevent emissions of particulate asbestos material to outside air when damage to equipment resulting from the wetting would be unavoidable. Upon request and supply of adequate information, the Administrator will determine whether damage to equipment resulting from wetting to comply with the provisions of this paragraph would be unavoidable. Such local exhaust ventilation systems shall be designed and operated to capture the asbestos particulate matter produced by the stripping and removal of friable asbestos material. There shall be no visible emissions to the outside air from such local exhaust ventilation and collection systems, except as provided in paragraph (f) of this section.

(5) Sources subject to this paragraph are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(6) The demolition of a building, structure, facility, or installation, pursuant to an order of an authorized representative of a State or local governmental agency, issued because that building is structurally unsound and in danger of imminent collapse is exempt from all but the following requirements of paragraph (d) of this section:

(i) The notification requirements specified by paragraph (d)(2) of this section;

(ii) The requirements on stripping of friable asbestos materials from previously removed units or sections as specified in paragraph (d)(4)(iv) of this section;

(iii) The wetting, as specified by paragraph (d)(4)(v) of this section, of friable asbestos materials that have been removed or stripped;

(iv) The portion of the structure being demolished that contains friable asbestos materials shall be adequately wetted during the wrecking operation.

(e) Spraying: There shall be no visible emissions to the outside air from the spray-on application of materials containing more than 1 percent asbestos, on a dry weight basis, used to insulate or fireproof equipment and machinery, except as provided in paragraph (f) of this section. Spray-on materials used to insulate or fireproof buildings, structures, pipes, and conduits shall contain less than 1 percent asbestos on a dry weight basis.

(f) Sources subject to this paragraph are exempt from the requirements of

§ 61.05(a), § 61.07, and § 61.09.

(2) Any owner or operator who intends to spray asbestos materials which contain more than 1 percent asbestos on a dry weight basis to insulate or fireproof equipment and machinery shall report such intention to the Administrator at least 20 days prior to the commencement of the spraying operation. Such report shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Location of spraying operation.

(iv) Procedures to be followed to meet the requirements of this paragraph.

(f) Rather than meet the no-visible-emission requirements as specified by paragraphs (a), (c), (d), (e), (h), (j), and (k) of this section, an owner or operator may elect to use the methods specified by § 61.23 to clean emissions containing particulate asbestos material before such emissions escape to, or are vented to, the outside air.

(g) Where the presence of uncombined water is the sole reason for failure to meet the no-visible-emission requirement of paragraphs (a), (c), (d), (e), (h), (j), or (k) of this section, such failure shall not be a violation of such emission requirements.

(h) Fabricating: There shall be no visible emissions to the outside air, except as provided in paragraph (f) of this section, from any of the following operations if they use commercial asbestos or from any building or structure in which such operations are conducted.

(1) The fabrication of cement building products.

(2) The fabrication of friction products, except those operations that primarily install asbestos friction materials on motor vehicles.

(3) The fabrication of cement or silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture; bulkheads, partitions and ceilings for marine construction; and flow control devices for the molten metal industry.

(i) Insulating: Molded insulating materials which are friable and wet-applied insulating materials which are friable after drying, installed after the effective date of these regulations, shall contain no commercial asbestos. The provisions of this paragraph do not apply to insulating materials which are spray applied; such materials are regulated under § 61.22(e).

(j) Waste disposal for manufacturing, fabricating, demolition, renovation and spraying operations: The owner or operator of any source covered under the provisions of paragraphs (c), (d), (e), or (h) of this section shall meet the following standards:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (j)(3) of this section, during the collection; processing, including incineration; packaging; transporting; or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (j)(1) of this section, an owner or operator may elect to use either of the disposal methods specified under (j)(3)(i) and (ii) of this section, or an alternative disposal method which has received prior approval by the Administrator:

(i) Treatment of asbestos-containing waste material with water:

(A) Control device asbestos waste shall be thoroughly mixed with water into a slurry and other asbestos-containing waste material shall be adequately wetted. There shall be no visible emissions to the outside air from the collection, mixing and wetting operations, except as provided in paragraph (f) of this section.

(B) After wetting, all asbestos-containing waste material shall be sealed into leak-tight containers while wet, and such containers shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(C) The containers specified under paragraph (j)(3)(i)(B) of this section shall be labeled with a warning label that states:

CAUTION

Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous
to Your Health

Alternatively, warning labels specified by Occupational Safety and Health Standards of the Department of Labor, Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.-93a(g)(2)(ii) may be used.

(ii) Processing of asbestos-containing waste material into non-friable forms:

(A) All asbestos-containing waste material shall be formed into non-friable pellets or other shapes and deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(B) There shall be no visible emissions to the outside air from the collection and processing of asbestos-containing waste material, except as specified in paragraph (f) of this section.

(4) For the purposes of this paragraph (j), the term all asbestos-containing waste material as applied to demolition and renovation operations covered by paragraph (d) of this section includes only friable asbestos waste and control device asbestos waste.

(k) Waste disposal for asbestos mills: The owner or operator of any source covered under the provisions of paragraph (a) of this section shall meet the following standard:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (k)(3) of this section, during the collection, processing, packaging, transporting or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of § 61.25.

(3) Rather than meet the requirement of paragraph (k)(1) of this section, an owner or operator may elect to meet the following requirements in paragraphs (k)(3)(i) and (ii), or use an alternative disposal method which has received prior approval by the Administrator:

(i) There shall be no visible emissions to the outside air from the transfer of control device asbestos waste to the tailings conveyor, except as provided in paragraph (f) of this section. Such waste shall be subsequently processed either as specified in paragraph (k)(3)(ii) of this section or as specified in paragraph (j)(3) of this section.

(ii) All asbestos-containing waste material shall be adequately mixed, with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, prior to deposition at a waste disposal site. Such agent shall be used as recommended for the particular dust by the manufacturer of the agent. There shall be no discharge of visible emissions to the outside air from the wetting operation except as specified in paragraph (f) of this section. Wetting may be suspended when the ambient temperature at the waste disposal site is less than −9.5°C (ca. 15°F). The ambient air temperature shall be determined by an appropriate measurement method with an accuracy of ±1°C (±2°F) and recorded at least at hourly intervals during the period that the operation of the wetting system is suspended. Records of such temperature measurements shall be retained at the source for a minimum of two years and made available for inspection by the Administrator.

(l) The owner of any inactive waste disposal site, which was operated by sources covered under § 61.22 (a), (c) or (h) and where asbestos-containing waste material produced by such sources was deposited, shall meet the following standards:

(1) There shall be no visible emissions to the outside air from an inactive waste disposal site subject to this paragraph, except as provided in paragraph (l)(5) of this section.

(2) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited, at intervals of 100 m (ca. 330 ft) or less, except as specified in paragraph (l)(4) of this section. Signs shall be posted in such a manner and location that a person may easily read the legend. The warning signs required by this paragraph shall conform to the requirements of 20" x 14" upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

LEGEND

ASBESTOS WASTE DISPOSAL SITE

Do Not Create Dust

Breathing Asbestos is Hazardous
to Your Health

Notation

1" Sans Serif, Gothic or Block

¼" Sans Serif, Gothic or Block

14 Point Gothic

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

(3) The perimeter of the site shall be fenced in a manner adequate to deter

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access by the general public, except as specified in paragraph (l)(4) of this section.

(4) Warning signs and fencing are not required where the requirements of paragraphs (l)(5) (i) or (ii) of this section are met, or where a natural barrier adequately deters access by the general public. Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access to the general public.

(5) Rather than meet the requirement of paragraph (l)(1) of this section, an owner may elect to meet the requirements of this paragraph or may use an alternative control method for emissions from inactive waste disposal sites which has received prior approval by the Administrator.

(i) The asbestos-containing waste material shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material, and a cover of vegetation shall be grown and maintained on the area adequate to prevent exposure of the asbestos-containing waste material; or

(ii) The asbestos-containing waste material shall be covered with at least 60 centimeters (ca. 2 feet) of compacted non-asbestos-containing material and maintained to prevent exposure of the asbestos-containing waste; or

(iii) For inactive waste disposal sites for asbestos tailings, a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion shall be applied. Such agent shall be used as recommended for the particular asbestos tailings by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[38 FR 8826, Apr. 6, 1973, as amended at 39 FR 16398, May 8, 1974; 40 FR 48299, Oct. 14, 1975]

§ 61.23 Air-cleaning.

If air-cleaning is elected, as permitted by §§ 61.22(f) and 61.22(d)(4)(iv), the requirements of this section must be met.

(a) Fabric filter collection devices must be used, except as noted in paragraphs (b) and (c) of this section. Such devices must be operated at a pressure drop of no more than 4 inches water gage, as measured across the filter fabric. The airflow permeability, as determined by ASTM method D737-69, must not exceed 30 $ft^3/min/ft^2$ for woven fabrics or 35 $ft^3/min/ft^2$ for felted fabrics, except that 40 $ft^3/min/ft^2$ for woven and 45 $ft^3/min/ft^2$ for felted fabrics is allowed for filtering air from asbestos ore dryers. Each square yard of felted fabric must weigh at least 14 ounces and be at least one-sixteenth inch thick throughout. Synthetic fabrics must not contain fill yarn other than that which is spun.

(b) If the use of fabric filters creates a fire or explosion hazard, the administrator may authorize the use of wet collectors designed to operate with a unit contacting energy of at least 40 inches water gage pressure.

(c) The administrator may authorize the use of filtering equipment other than that described in paragraphs (a) and (b) of this section if the owner or operator demonstrates to the satisfaction of the administrator that the filtering of particulate asbestos material is equivalent to that of the described equipment.

(d) All air-cleaning equipment authorized by this section must be properly installed, used, operated, and maintained. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

[38 FR 8826, Apr. 6, 1973, as amended at 40 FR 48302, Oct. 14, 1975]

§ 61.24 Reporting.

The owner or operator of any existing source to which this subpart is applicable shall, within 90 days after the effective date, provide the following information to the administrator:

(a) A description of the emission control equipment used for each process;

(b) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage.

(1) If the fabric filter device utilizes a woven fabric, the airflow permeability in $ft^3/min/ft^2$; and, if the fabric is synthetic, indicate whether the fill yarn is spun or not spun.

(2) If the fabric filter device utilizes a felted fabric, the density in oz/yd^2, the minimum thickness in inches, and the airflow permeability in $ft^3/min/ft^2$.

(c) For sources subject to §§ 61.22(j) and 61.22(k):

(1) A brief description of each process that generates asbestos-containing waste material.

(2) The average weight of asbestos-containing waste material disposed of, measured in kg/day.

(3) The emission control methods used in all stages of waste disposal.

(4) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(d) For sources subject to § 61.22(l):

(1) A brief description of the site.

(2) The method or methods used to comply with the standard, or alternative procedures to be used.

(e) Such information shall accompany the information required by § 61.10. The information described in this section shall be reported using the format of Appendix A of this part.

[38 FR 8826, Apr. 6, 1973, as amended at 40 FR 48302, Oct. 14, 1975]

§ 61.25 Waste disposal sites.

In order to be an acceptable site for disposal of asbestos-containing waste material under § 61.22 (j) and (k), an active waste disposal site shall meet the requirements of this section.

(a) There shall be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, except as provided in paragraph (e) of this section.

(b) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited, at intervals of 100 m (ca. 330 ft) or less except as specified in paragraph (d) of this section. Signs shall be posted in such a manner and location that a person may easily read the legend. The warning signs required by this paragraph shall conform to the requirements of 20" x 14" upright format signs specified in 29 CFR 1910.145(d)(4) and this paragraph. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

LEGEND

ASBESTOS WASTE DISPOSAL SITE

Do Not Create Dust

Breathing Asbestos
is Hazardous to Your Health

Notation

1" Sans Serif, Gothic or Block

¾" Sans Serif, Gothic or Block

14 Point Gothic

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

(c) The perimeter of the disposal site shall be fenced in order to adequately deter access to the general public except as specified in paragraph (d) of this section.

(d) Warning signs and fencing are not required where the requirements of paragraph (e)(1) of this section are met, or where a natural barrier adequately deters access to the general public. Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access to the general public.

(e) Rather than meet the requirement of paragraph (a) of this section, an owner or operator may elect to meet the requirements of paragraph (e)(1) or (e)(2) of this section, or may use an alternative control method for emissions from active waste disposal sites which has received prior approval by the Administrator.

(1) At the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material.

(2) At the end of each operating day, or at least once every 24-hour period while the disposal site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion. Such agent shall be used as recommended for the particular dust by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

[40 FR 48302, Oct. 14, 1975]

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9.2.3 DOL Regulations,

29 CFR 1910.1001

§ 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 excee.1 100 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.
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.

(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

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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.

[39 FR 23502, June 27, 1974, as amended at 41 FR 11506, Mar. 19, 1976]

Subpart I—Personal Protective Equipment

§ 1910.132 General requirements.

(a) *Application.* Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

(b) *Employee-owned equipment.* Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

(c) *Design.* All personal protective equipment shall be of safe design and construction for the work to be performed.

§ 1910.133 Eye and face protection.

(a) *General.* (1) Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazard of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

(2) Protectors shall meet the following minimum requirements:

(i) They shall provide adequate protection against the particular hazards for which they are designed.

(ii) They shall be reasonably comfortable when worn under the designated conditions.

(iii) They shall fit snugly and shall not unduly interfere with the movements of the wearer.

(iv) They shall be durable.

(v) They shall be capable of being disinfected.

(vi) They shall be easily cleanable.

(vii) Protectors should be kept clean and in good repair.

(3) Persons whose vision requires the use of corrective lenses in spectacles, and who are required by this standard to wear eye protection, shall wear goggles or spectacles of one of the following types:

(i) Spectacles whose protective lenses provide optical correction.

(ii) Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles.

(iii) Goggles that incorporate corrective lenses mounted behind the protective lenses.

(4) Every protector shall be distinctly marked to facilitate identification only of the manufacturer.

(5) When limitations or precautions are indicated by the manufacturer, they shall be transmitted to the user and care taken to see that such limitations and precautions are strictly observed.

(6) Design, construction, testing, and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection, Z87.1–1968.

§ 1910.134 Respiratory protection.

(a) *Permissible practice.* (1) In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

(2) Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include the requirements outlined in paragraph (b) of this section.

(3) The employee shall use the provided respiratory protection in accordance with instructions and training received.

(b) *Requirements for a minimal acceptable program.* (1) Written standard operating procedures governing the selection and use of respirators shall be established.

(2) Respirators shall be selected on the basis of hazards to which the worker is exposed.

(3) The user shall be instructed and trained in the proper use of respirators and their limitations.

(4) Where practicable, the respirators should be assigned to individual workers for their exclusive use.

(5) Respirators shall be regularly cleaned and disinfected. Those issued for the exclusive use of one worker should be cleaned after each day's use, or more often if necessary. Those used by more than one worker shall be thoroughly cleaned and disinfected after each use.

(6) Respirators shall be stored in a convenient, clean, and sanitary location.

(7) Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use such as self-contained devices shall be thoroughly inspected at least once a month and after each use.

(8) Appropriate surveillance of work area conditions and degree of employee exposure or stress shall be maintained.

(9) There shall be regular inspection and evaluation to determine the continued effectiveness of the program.

(10) Persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent. The respirator user's medical status should be reviewed periodically (for instance, annually).

(11) Approved or accepted respirators shall be used when they are available. The respirator furnished shall provide adequate respiratory protection against the particular hazard for which it is designed in accordance with standards established by competent authorities. The U.S. Department of Interior, Bureau of Mines, and the U.S. Department of Agriculture are recognized as such authorities. Although respirators listed by the U.S. Department of Agriculture continue to be acceptable for protection against specified pesticides, the U.S. Department of the Interior, Bureau of Mines, is the agency now responsible for testing and approving pesticide respirators.

(c) *Selection of respirators.* Proper selection of respirators shall be made according to the guidance of American National Standard Practices for Respiratory Protection Z88.2–1969.

(d) *Air quality.* (1) Compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration shall be of high purity. Oxygen shall meet the re-

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quirements of the United States Pharmacopoeia for medical or breathing oxygen. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Compressed oxygen shall not be used in supplied-air respirators or in open circuit self-contained breathing apparatus that have previously used compressed air. Oxygen must never be used with air line respirators.

(2) Breathing air may be supplied to respirators from cylinders or air compressors.

(i) Cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178).

(ii) The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to insure that it meets the specifications in subparagraph (1) of this paragraph.

(3) Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

(4) Breathing gas containers shall be marked in accordance with American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification - GG-B-00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

(e) *Use of respirators.* (1) Standard procedures shall be developed for respirator use. These should include all information and guidance necessary for their proper selection, use, and care. Possible emergency and routine uses of respirators should be anticipated and planned for.

(2) The correct respirator shall be specified for each job. The respirator type is usually specified in the work procedures by a qualified individual supervising the respiratory protective program. The individual issuing them shall be adequately instructed to insure that the correct respirator is issued. Each respirator permanently assigned to an individual should be durably marked to indicate to whom it was assigned. This mark shall not affect the respirator performance in any way. The date of issuance should be recorded.

(3) Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies. Personnel shall be familiar with these procedures and the available respirators.

(i) In areas where the wearer, with failure of the respirator, could be overcome by a toxic or oxygen-deficient atmosphere, at least one additional man shall be present. Communications (visual, voice, or signal line) shall be maintained between both or all individuals present. Planning shall be such that one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist the other(s) in case of emergency.

(ii) When self-contained breathing apparatus or hose masks with blowers are used in atmospheres immediately dangerous to life or health, standby men must be present with suitable rescue equipment.

(iii) Persons using air line respirators in atmospheres immediately hazardous to life or health shall be equipped with safety harnesses and safety lines for lifting or removing persons from hazardous atmospheres or other and equivalent provisions for the rescue of persons from hazardous atmospheres shall be used. A standby man or men with suitable self-contained breathing apparatus shall be at the nearest fresh air base for emergency rescue.

(4) Respiratory protection is no better than the respirator in use, even though it is worn conscientiously. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

(5) For safe use of any respirator, it is essential that the user be properly instructed in its selection, use, and maintenance. Both supervisors and workers shall be so instructed by competent persons. Training shall provide the men an opportunity to handle the respirator, have it fitted properly, test its face-piece-to-face seal, wear it in normal air for a long familiarity period, and, finally, to wear it in a test atmosphere.

(i) Every respirator wearer shall receive fitting instructions including demonstrations and practice in how the respirator should be worn, how to adjust it, and how to determine if it fits properly. Respirators shall not be worn when conditions prevent a good face seal. Such conditions may be a growth of beard, sideburns, a skull cap that projects under the facepiece, or temple pieces on glasses. Also, the absence of one or both dentures can seriously affect the fit of a facepiece. The worker's diligence in observing these factors shall be evaluated by periodic check. To assure proper protection, the facepiece fit shall be checked by the wearer each time he puts on the respirator. This may be done by following the manufacturer's facepiece fitting instructions.

(ii) Providing respiratory protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of eye glasses extend through the sealing edge of the full facepiece. As a temporary measure, glasses with short temple bars or without temple bars may be taped to the wearer's head. Wearing of contact lenses in contaminated atmospheres with a respirator shall not be allowed. Systems have been developed for mounting corrective lenses inside full facepieces. When a workman must wear corrective lenses as part of the facepiece, the facepiece and lenses shall be fitted by qualified individuals to provide good vision, comfort, and a gas-tight seal.

(iii) If corrective spectacles or goggles are required, they shall be worn so as not to affect the fit of the facepiece. Proper selection of equipment will minimize or avoid this problem.

(f) *Maintenance and care of respirators.* (1) A program for maintenance and care of respirators shall be adjusted to the type of plant, working conditions, and hazards involved, and shall include the following basic services:

(i) Inspection for defects (including a leak check),
(ii) Cleaning and disinfecting,
(iii) Repair,
(iv) Storage

Equipment shall be properly maintained to retain its original effectiveness.

(2) (i) All respirators shall be inspected routinely before and after each use. A respirator that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly to assure that it is in satisfactory working condition.

(ii) Self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be fully charged according to the manufacturer's instructions. It shall be determined that the regulator and warning devices function properly.

(iii) Respirator inspection shall include a check of the tightness of connections and the condition of the facepiece, headbands, valves, connecting tube, and canisters. Rubber or elastomer parts shall be inspected for pliability and signs of deterioration. Stretching and manipulating rubber or elastomer parts with a massaging action will keep them pliable and flexible and prevent them from taking a set during storage.

(iv) A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

(3) Routinely used respirators shall be collected, cleaned, and disinfected as frequently as necessary to insure that proper protection is provided for the wearer. Each worker should be briefed on the cleaning procedure and be assured that he will always receive a clean and disinfected respirator. Such assurances are of greatest significance when respirators are not individually assigned to workers. Respirators maintained for emergency use shall be cleaned and disinfected after each use.

(4) Replacement or repairs shall be done only by experienced persons with parts designed for the respirator. No attempt shall be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

(5) (i) After inspection, cleaning, and necessary repair, respirators shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Respirators placed at stations and work areas for emergency use should be quickly accessible at all times and should be stored in compartments built for the purpose. The compartments should be clearly marked. Routinely used respirators, such as dust respirators, may be placed in plastic bags. Respirators should not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

(ii) Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position and function will not be impaired by the elastomer setting in an abnormal position.

(iii) Instructions for proper storage of emergency respirators, such as gas masks and self-contained breathing apparatus, are found in "use and care" instructions usually mounted inside the carrying case lid. . . .

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EXHIBIT NO. 1
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Chrysotile Asbestos Fiber Material Safety Data Sheet

I JOHNS-MANVILLE CORP. & SUBSIDIARIES

P.O. Box 5108, Denver, Colo. 80217

Emergency Telephone No: 303-770-1000

Chemical Name & Synonyms: Chrysotile Asbestos
Trade Name & Synonyms: Asbestos
Chemical Family: Fibrous Mineral Silicates
Formula: $Mg_3 (Si_2O_5) (OH)_4$

II HAZARDOUS INGREDIENTS

	TLV (Units)
Paints, Preservatives & Solvents	
Pigments, Catalyst, Vehicle, Solvents, Additives and Others	N/A
Alloys and Metallic Coatings	
Base Metal, Alloys, Metallic Coatings, Filler Metal plus Coating or Core Flux, Others	N/A
Hazardous Mixtures of Other Liquids, Solids or Gases	
Chrysotile Asbestos Fiber Approx. 100% (* For TLV—See Section V)	*

III PHYSICAL DATA

Boiling Point (°F.), Vapor Pressure (mm Hg.)	N/A
Vapor Density (Air=1), Solubility in Water	N/A
Appearance and Odor: White Fibrous dry material—no odor	
Specific Gravity (H_2O=1)	2.4-2.6
Percent volatile by volume (%)	N/A
Evaporation rate (_____=1)	N/A

IV FIRE AND EXPLOSION HAZARD DATA

Material is non-flammable. No fire or explosion hazard

V HEALTH HAZARD DATA

Threshold Limit Value

OSHA Exposure Limits 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.

Ceiling Concentrations. 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. (Refer to OSHA Standard for Exposure to Asbestos Dust, Federal Register, Volume 37, No. 110—Wednesday, June 7, 1972, paragraph (h) (2).

Emergency and First Aid Procedures

Avoid breathing excessive dust when handling, dumping and mixing. See caution label on bag.

VI REACTIVITY DATA

Stability	Stable
Incompatability (materials to avoid)	N/A
Hazardous Decomposition Products	None
Hazardous Polymerization	Will not occur

VII SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled

Vacuum clean spillage. Repair broken bags. If sweeping is necessary, wet down spillage. Use approved respiratory equipment when required.

Waste Disposal Method

Disposal of waste in accordance with OSHA Standard for Exposure to Asbestos Dust, Federal Register, Volume 37, No. 110—Wednesday, June 7, 1972, paragraph (h) (2).

VIII SPECIAL PROTECTION INFORMATION

Respiratory Protection

Use respirators as recommended by the OSHA Standard for Exposure to Asbestos Dust, Federal Register, Volume 37, No. 110—Wednesday, June 7, 1972, paragraph (d).

Ventilation

Control with mechanical dust collection equipment to within TLV. (See American National Standards Institute booklet, Z9.2—1971).

Other Protective Equipment

Use special clothing as required by the OSHA Standard for Exposure to Asbestos Dust, Federal Register, Volume 37, No. 110—Wednesday, June 7, 1972, paragraph (d).

IX SPECIAL PRECAUTIONS

Precautions to be taken in handling and storing

Maintain good housekeeping practices. Vacuum clean waste and place in closed containers.

Other precautions

SEE CAUTION LABEL ON BAG.

While the information and recommendations set forth herein are believed to be accurate as of the date hereof, JOHNS-MANVILLE MAKES NO WARRANTY WITH RESPECT THERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

Johns-Manville JM
Asbestos Fiber Sales • P.O.Box 5108 • Denver, Colo. 80217 • (303) 770-1000
Canadian Johns-Manville Co., Ltd • Asbestos Fiber Division • P.O. Box 1500 • Asbestos, Quebec, Canada J1T 3N2 (819) 879-5433

3 mm x 3 mm and such that the square of Nuclepore fits within the circumference of the grid. Pass each of the filter sections over a static eliminator and then place each of the three sections carbon-side down on separate specimen grids previously placed in the modified Jaffe Washer. Using a microsyringe, place a 10-µl drop of chloroform on each filter section resting on a grid and then saturate the filter pad until pooling of the solvent occurs below the ridge formed by the glass slides inserted under the layer of filter papers. Place the cover on the petri dish and allow the grids to remain in the washer for approximately 24 hours. Do not allow the chloroform to completely evaporate before the grids are removed. To remove the grids from the washer lift the screen support with the grid resting upon it and set this in a spot plate depression to allow evaporation of any solvent adhering to the grid. The grid is now ready for analysis or storage.

8.2B Millipore - Condensation Washer Technique

8.2B.1 Operation of Condensation Washer

Fill the extractor flask to 40% capacity with acetone. Filter the acetone through 0.1-µm Nuclepore filter paper before using. Adjust the tap water flow rate to 10 ml/sec by allowing the water exiting from the cold finger to run into a graduated cylinder for 30 seconds. Set the variable transformer, regulating the heater power-input, to approximately 45 volts. Sufficient heat should be applied to generate acetone vapors at the required condensation or reflux level without boiling or simmering. The reflux level should be even with the top of the cold finger and just below the stainless steel grid. (Important: See Note 1). After the system has been running for twenty minutes, check the reflux level of the acetone. Place a heavily lined index card behind the adaptor so that when viewed from the front of the adaptor the cold finger is parallel to the heavy lines on this card. Locate the reflux level by noting the illusionary wavy motion of the heavy lines on the index card. If the reflux level is too high, increase, or if too low, decrease the tap water flow rate. Do not allow pooling of the solvent to occur on the grids. At very low flow rates keep a careful check to ensure that the water valve does not shut itself off. To account for changes in the tap water temperature, establish the correct flow rate daily.

NOTE 1: The relative position of the acetone condensation level to the grid level is critical to the successful operation of the condensation washer. If the condensation level is too low, the Millipore filter will not be sufficiently removed within a reasonable period of time and the asbestos fibers cannot be successfully counted; if the level is too high, excessive washing occurs with a resulting loss of fibers and rupture of the carbon film. As each extractor has different characteristics, several test runs should be made on blank Millipore-loaded grids to determine the optimum operating conditions.

NOTE 2: It has been suggested that the rate of acetone condensation, observed as drops from the end of the cold finger, should be 10 drops per 30-45 seconds.

NOTE 3: A constant pressure regulator may be required in the water line if a constant flow cannot be otherwise attained.

8.2B.2 Vacuum Filtration Unit

Assemble the vacuum filtration unit. Place a 0.45-µm Millipore filter on the glass frit. Turn on the suction and center the filter on the frit. Attach the filter funnel and turn off suction.

8.2B.3 Sample Filtration

See 8.1.1.

8.2B.4 Sample Drying

Remove the filter funnel and place the Millipore filter in a petri dish in an asbestos-free oven at 95° C for at least two hours to dry.

8.2B.5 Sampling of Filter

Using a well sharpened (1/8 inch diameter) cork borer, cut three circular sections from the filter. Keep one-half of the filter undisturbed for future reference or if an

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ashing step is required (See 8.5). Avoid sampling near the perimeter of the filtration area.

8.2B.6 Grid Transfer

Pass each filter section over a static eliminator and then place each section particulate side down on carbon coated specimen grids previously placed in the brass holder. Add a 10-µl drop of acetone to each of the grids using a micro syringe. Place the brass holder on the cold finger of the condensation washer which has been charged with acetone. After the correct reflux level has been established (8.2B.1) insert the brass block holding the grids and check a few minutes later to make certain that the acetone reflux is near but below grid level. Allow the acetone to reflux for 7-8 hours to dissolve away the filter and leave the residue deposited on the carbon substrate of the grid. Turn off the heating mantle. Remove the brass block holding the grids when no drops of acetone can be seen falling from the cold finger. The grids are now ready for analysis or storage.

NOTE 1: The addition of 10 µl of acetone directly to the filter, while recommended, may, in the opinion of some investigators, increase the risk of removing particulates from the filter. There are no data available to show it has a deleterious effect.

8.4 Electron Microscopic Examination

8.4.1 Microscope Alignment and Magnification Calibration

Following the manufacturer's recommendations carry out the necessary alignment procedures for optimum specimen examination in the electron microscope. Calibrate the routinely used magnifications using a carbon grating replica.

NOTE 1: Screen magnification is not necessarily equivalent to plate magnification.

8.4.2 Grid Preparation Acceptability

After inserting the specimen into the microscope adjust the magnification low enough (300X - 1000X) to permit viewing complete grid squares. Inspect at least 10 grid squares for fiber loading and distribution, debris contamination, and carbon film continuity.

Reject the grid for counting if:

1) The grid is too heavily loaded with fibers to perform accurate counting and diffraction operations. A new sample preparation either from a smaller volume of water or from a dilution with filtered distilled water must then be prepared.

2) The fiber distribution is noticeably uneven. A new sample preparation is required.

3) The debris contamination is too severe to perform accurate counting and diffraction operations. If the debris is largely organic the filter must be ashed and redispersed (see 8.5). If inorganic the sample must be diluted and again prepared.

4) The majority of grid squares examined have broken carbon films. A different grid preparation from the same initial filtration must be substituted.

8.4.3 Procedure for Fiber Counting

There are two methods commonly used for fiber counting. In one method (A) 100 fibers, contained in randomly selected fields of view, are counted. The number of fields plus the area of a field of view must be known when using this method. In the other method (B), all fibers (at least 100) in several grid squares or 20 grid squares are counted. The number of grid squares counted and the average area of one grid square must be known when using this method.

NOTE 1: The method to use is dependent upon the fiber loading on the grid and it is left to the judgement of the analyst to select the optimum method. The following guidelines can be used: If it is estimated that a grid square (80 µm x 80 µm) contains 50-100 fibers at a screen magnification of 20000X it is convenient to use the field-of-view counting method. If the estimate is less than 50, the grid square method of counting should be chosen. On the other hand, if the fiber count

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is estimated to be over 300 fibers per grid square, a new grid containing less fibers must be prepared (through dilution or filtration of a smaller volume of water).

8.4.3A Field-of-View Method

After determining that a fiber count can be obtained using this method adjust the screen magnification to 10-20000X. Select a number of grid squares which would be as representative as possible of the entire analyzable grid surface. From each of these squares select a sufficient number of fields of view for fiber counting. The number of fields of view per grid square is dependent upon the fiber loading. If more than one field of view per grid square is selected, scan the grid opening orthogonally in an arbitrary pattern which prevents overlapping of fields of view. Carry out the analysis by counting, measuring and identifying (see 8.8.4) approximately 50 fibers on each of two grids.

The following rules should be followed when using the field of view method of fiber counting. Although these rules were derived for a circular field of view they can be modified to apply to square or rectangular designs.

1) Count all fibers contained within the counting area and not touching the circumference of the circle.

2) Designate the upper right-hand quadrant as I and number in clockwise order. Count all fibers touching or intersecting the arc of quadrants I or IV. Do not count fibers touching or intersecting the arc of quadrants II or III.

3) If a fiber intersects the arc of both quadrants III and IV or I and II count it only if the greater length was outside the arc of quadrants IV and I, respectively.

4) Count fibers intersecting the arc of both quadrants I and III but not those intersecting the arc of both II and IV.

These rules are illustrated in Fig. 3.

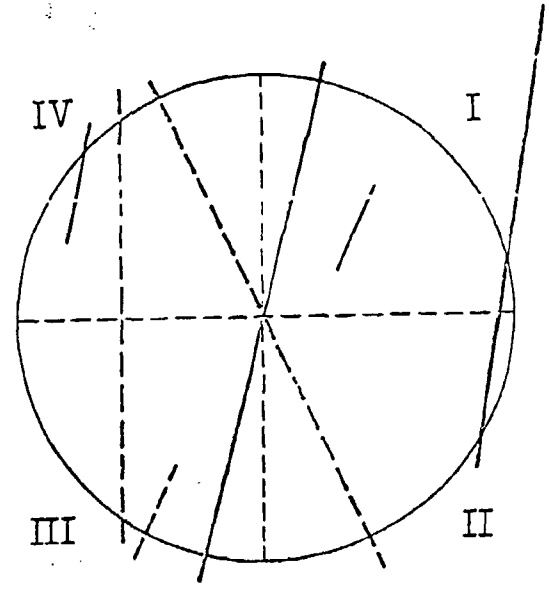

Figure 3. Illustration of Counting Rules for Field-of-View Method

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8.4.3B Grid Square Method

After determining that a fiber count can be obtained using this method adjust the screen magnification to 10-20000X. Position the grid square so that scanning can be started at the left upper corner of the grid square. While carefully examining the grid, scan left to right, parallel to the upper grid bar. When the perimeter of the grid square is reached adjust the field of view up one field width and scan in the opposite direction. The tilting section of the fluorescent screen may be used conveniently as the field of view. Examine the square until all the area has been covered. The analysis should be carried out by counting, measuring and identifying (see 8.4.4) approximately 50 fibers on each of two grids or until 10 grid squares on each of two grids have been counted. Do not count fibers intersecting a grid bar.

8.4.4 Measurement and Identification

Measure and record the length and width of each fiber having an aspect ratio greater than or equal to three. Disregard obvious biological, bacteriological fibers and diatom fragments. Examine the morphology of each fiber using optical viewing if necessary. Tentatively identify, by reference to the UICC standards, chrysotile or possible amphibole asbestos. Attempt to obtain a diffraction pattern of each fiber. Move the suspected fiber image to the center of the screen and insert a suitable selected area aperture into the electron beam so that the fiber image, or a portion of it, is in the illuminated area. The size of the aperture and the portion of the fiber should be such that particles other than the one to be examined are excluded from the selected area. If an incomplete diffraction pattern is obtained move the particle image around in the selected area to get a clearer diffraction pattern or to eliminate possible interferences from neighboring particles.

Determine whether or not the fiber is chrysotile or an amphibole by comparing the diffraction pattern obtained to the diffraction patterns of known standard asbestos fibers. Confirm the tentative identification of chrysotile and amphibole asbestos from their electron diffraction patterns. Classify each fiber as chrysotile, amphibole, non-asbestos, no diffraction and ambiguous.

NOTE 1: It is convenient to use a tape recorder during the examination of the fibers to record all pertinent data. This information can then be summarized on data sheets or punched cards for subsequent automatic data processing.

NOTE 2: Chrysotile fibers occur as single fibrils, or in bundles. The fibrils generally show a tubular structure with a hollow canal, although the absence of the canal does not rule out its identification. Amphibole asbestos fibers usually exhibit a lath-like structure with irregular ends, but occasionally will resemble chrysotile in appearance.

NOTE 3: The positive identification of asbestos by electron diffraction requires some judgement on the part of the analyst because some fibers give only partial patterns. Chrysotile shows unique prominent streaks on the layer lines nearest the central one and a triple set of double spots on the second layer line. The streaks and the set of double spots are the distinguishing characteristics of chrysotile required for identification. Amphibole asbestos requires a more complete diffraction pattern to be positively identified. As a qualitative guideline, layer lines for amphibole, without the unique streaks (some streaking may be present), of chrysotile, should be present and the arrangement of diffraction spots along the layer lines should be consistent with the amphibole pattern. The pattern should be distinct enough to establish these criteria.

NOTE 4: Chrysotile and thin amphibole fibers may undergo degradation in an electron beam; this is particularly noticeable in small fibers. It may exhibit a pattern for a 1-2 seconds and disappear and the analyst must be alert to note the characteristic features.

NOTE 5: An ambiguous fiber is a fiber that gives a partial electron diffraction pattern resembling asbestos, but insufficient to provide positive identification.

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8.4.5 Determination of Grid Square Area

Measure the dimensions of several representative grid squares from each batch of grids with an optical microscope. Calculate the average area of a grid square. This should be done to compensate for variability in grid square dimensions.

8.5 Ashing

Some samples contain sufficiently high levels of organic material that an ashing step is required before fiber identification and counting can be carried out. If a Nuclepore filter was used for the original preparation and if the preliminary examination of the initial preparation shows that this condition exists, carry out the filtration step on a new water sample using a .45-μm Millipore filter. If a Millipore filter was used initially the unused half from 8.2B.5 can be ashed.

NOTE 1: A Millipore filter is specified because it is more readily oxidized under the specified ashing conditions.

Place the dried Millipore filter paper containing the collected sediment into a glass vial (28 mm diameter x 80 mm high). Position the filter such that the filtration side touches the glass wall. Place the vial in an upright position in the low temperature asher. Operate the asher at 50 watts (13.56 MHz) power and 2 psi oxygen pressure. Ash the filter until a thin film of white ash remains. The time required is generally 6 to 8 hours. Allow the ashing chamber to slowly reach atmospheric pressure and remove the vial. Add 10 ml of filtered distilled water containing 0.1 percent filtered Aerosol OT to the vial. Place the vial in an ultrasonic bath for 1/2 hour to disperse the ash. Dilute the sample if required.

Assemble the 25 mm diameter filtering apparatus. (See Note 1) Center a 25 mm diameter 0.45-μm Millipore or .1-μm Nuclepore filter (with the 2-μm Millipore backing) on the glass frit. Apply suction and recenter the filter if necessary. Attach the filter funnel and turn off the suction. Add the water containing the dispersed ash from the vial to the filter funnel. Apply suction and filter the sample. After drying this filter it is ready to be used in preparing sample grids as in 8.2A or 8.2B.

NOTE 2: In specifying a 25-mm diameter filter it is assumed that the ashing step is necessary mainly because of the presence of organic material and that the smaller filtering area is desirable from the point of view of concentrating the fibers. If the sample contains mostly inorganic debris such that the smaller filtering area will result in over-loading the filter, the 47-mm diameter filter should be used.

NOTE 3: It will be noted that a 10-ml volume is filtered in this case instead of the minimum 50-ml volume specified in 8.1.1. These volumes are consistent when it is considered that there is approximately a 5-fold difference in effective filtration area between the 25-mm diameter and 47-mm diameter filters.

8.6 Determination of Blank Level

Carry out a blank determination with each batch of samples prepared, but a minimum of one per week. Filter a fresh supply (500 ml) of distilled, deionized water through a clean .1-μm membrane filter. Using the selected filter type, filter 200 ml of this water, prepare the electron microscope grid, and count exactly as in the procedures 8.1 - 8.4. Examine 20 grid squares and record this number of fibers. A maximum of two fibers in 20 grid squares is acceptable for the blank sample.

NOTE 1: The monitoring of the background level of asbestos is an integral part of the procedure. Upon initiating asbestos analytical work, blank samples must be run to establish the initial suitability of the laboratory environment, cleaning procedures, and reagents for carrying out asbestos analyses. Analytical determinations of asbestos can be carried out only after an acceptably low level of contamination has been established.

9. Calculations

9.1 Fiber Concentrations

Grid Square Counting Method - If the Grid Square Method of counting is employed, use the following formula to calculate the total asbestos fiber concentration in MFL.

$$C = (F \times A_f) / (G \times A_g \times V_o \times 1000)$$

If ashing is involved use the same formula but substituting the effective filtration area of the 25-mm diameter filter for A_f instead of that for the 47-

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mm diameter filter. If one-half the filter is ashed, multiple C by two.

C = Fiber concentration (MFL)

F = number of fibers identified in "G" grid squares

A_f = effective filtration area of filter paper (mm^2) used in grid preparation used for fiber counting

A_g = Average area of one grid square (mm^2)

G = number of grid squares analyzed

V_o = original volume of sample filtered (ml)

Field-of-View Counting Method - If the Field-of-View Method of counting is employed use the following formula to calculate the total asbestos fiber concentrations (MFL)

$$C = (F \times A_f \times 1000) / (A_v \times Z \times V_o)$$

If ashing is involved use the same formula but substituting the effective filtration area of the 25-mm diameter filter for A_f instead of that for the 47-mm diameter filter.

C = fiber concentration (MFL)

F = number of fibers identified in area examined ($A_v \times Z$)

A_f = effective filtration area of filter paper (mm^2) used in grid preparation for fiber counting

A_v = area of one field of view (μm^2)

Z = number of fields of view examined

V_o = original volume of sample filtered (ml)

9.2 Estimated Mass Concentration

Calculate the mass (ug) of each fiber counted using the following formula:

$$M = L \times W^2 \times D \times 10^{-6}$$

If the fiber content is predominantly chrysotile, the following formula may be used:

$$M = \frac{\pi}{4} \times L \times W^2 \times D \times 10^{-6}$$

where M = mass (µg)

L = length (µm)

W = width (µm)

D = density of fibers (g/cm^3)

Then calculate the mass concentration (µg/l) employing the following formula.

$$M_c = C \times \bar{M}_f \times 10^6$$

where M_c = mass concentration (µg/l)

C = fiber concentration (MFL)

$\bar{M}_f$ = mean mass per fiber (µg)

To calculate $\bar{M}_f$ use the following formula:

$$\bar{M}_f = \sum_{i=1}^{n} M_i / n$$

where M = mass of each fiber, respectively

n = number of fibers counted

NOTE 1: Because many of the amphibole fibers are lath shaped rather than square in cross section the computed mass will tend to be high since laths will in general tend to lie flat rather than on edge.

NOTE 2: Assume the following densities: Chrysotile 2.5, Amphibole 3.25

9.3 Aspect Ratio

The aspect ratio for each fiber is calculated by dividing the length by the width.

10. Reporting

10.1 Report the following concentration as MFL

a. Total fibers

b. Chrysotile

c. Amphibole

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10.2 Use two significant figures for concentrations greater than 1 MFL, and one significant figure for concentrations less than 1 MFL.

10.3 Tabulate the size distribution, length and width.

10.4 Tabulate the aspect ratio distribution.

10.5 Report the calculated mass as ug/l.

10.6 Indicate the detection limit in MFL.

10.7 Indicate if less than five fibers were counted.

10.8 Include remarks concerning pertinent observations, (clumping, amount of organic matter, debris) amount of suspected though not identifiable as asbestos (ambiguous).

11. Precision

11.1 Intra Laboratory

The precision that is obtained within an individual laboratory is dependent upon the number of fibers counted. If 100 fibers are counted and the loading is at least 3.5 fibers/grid square, computer modeling of the counting procedure shows a relative standard deviation of about 10% can be expected.

In actual practice some degradation from this precision will be observed but should not exceed ± 15% if several grids are prepared from the same filtered sample. The relative standard deviation of analyses of the same water sample in the same laboratory will increase due to sample preparation errors and a relative standard deviation of about ± 25 - 30% will occur. As the number of fibers counted decreases, the precision will also decrease approximately proportional to $\sqrt{N}$ where N is the number of fibers counted.

11.2 Inter Laboratory

While there have been numerous inter laboratory testing programs, there have been few carried out using the same procedure. Those that have been done indicate that agreement within a factor of two is achieved if 100 fibers can be counted.

12. Accuracy

12.1 Fiber concentrations

As no standard reference materials are available, only approximate estimates of the accuracy of the procedure can be made. At 1 MFL, it is estimated that the results should be within a factor of 10 of the actual asbestos fiber content.

This method requires the positive identification of a fiber to be asbestos as a means for its quantitative determination. As the state-of-the art precludes the positive identification of all of the asbestos fibers present, the results by this method, as expressed as MFL, will be biased on the low side and assuming no fiber loss represent .2 - .6 of the total asbestos fibers present.

12.2 Mass concentrations

As in the case of the fiber concentrations, no standard samples of the size distribution found in water are available. The accuracy of the mass determination should be somewhat better than the fiber determination because a larger fraction of the large fibers, which contribute the major portion of the mass, are identifiable. This will reduce the bias of low results due to difficulties in identification. At the same time, the assumption that the thickness of the fiber equals the width will result in a positive error in determining the volume of the fiber and thus give high results for the mass.

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9.1.2 NIOSH Sampling Data Sheet #2.02 (9/4/75)

Source: NIOSH Manual of Sampling Data Sheets, 1977 Edition

Substance:

Asbestos

Standard:

8-hour time-weighted average: 5 fibers greater than 5 micrometers long per cubic centimeter. After July 1, 1976, this standard is reduced to 2 fibers per cubic centimeter.

Ceiling: 10 fibers greater than 5 micrometers long per cubic centimeter.

Reference: 29 CFR 1910.93a

Analytical Method:

The fibers are collected on filters and counted under a microscope. The filters are mounted on a clean slide and cleared. The fibers are counted with a microscope using 400-450 magnification and phase contrast microscopy.

Sampling Equipment:

Personal Sampler Pump: A calibrated pump whose flow rate can be determined to an accuracy of ± 5%. The pump must be calibrated with a representative filter and filter holder in line.

Filter Holder: 3-piece, 37-mm filter holder and back-up pad.

Filter: 0.8-micrometer pore size mixed cellulose membrane filter.

Sample Size:

The recommended volume of air sampled depends on the asbestos fiber concentration and the microscope used to count the fibers. If more than 20 fibers are present in a single field, too much sample has been collected for an accurate count. To minimize counting error, the average number of fibers counted per field depends upon the microscope's field area, which is usually between 0.003 and 0.007 mm^2, and the asbestos concentration. The following table estimates recommended sampling times at the recommended flow rate of 1.5 lpm:

Recommended Sampling Time in Minutes

Microscope Field Area (mm^2)	.003	.005	.007
Suspected Concentration 10 fibers/cc	57	34	24
5	75	68	48
2	95	85	85

Sampling Procedure:

1. Assemble the filter and three-piece filter holder and close firmly to insure that the center ring seals the edge of the filter. Examine the filter holder for a good filter seal. If the filter holder will not seal tightly, discard it.
2. Attach the filter holder to the sampling pump with a 1/4 inch diameter, 3-foot piece of tubing, and an adaptor. The adaptor is used to provide a tight connection between the filter holder and tubing.
3. Remove the face cap from the filter holder and clip the filter holder to the worker's lapel. The filter's open face should be pointed down.
4. Turn the pump on and begin sample collection. Periodically check the pump's flow rate and readjust it if necessary.
5. Terminate sampling at the predetermined time and note the sample's flow rate, collection time, ambient temperature, and pressure. If a pressure reading is unavailable, record the elevation.
6. Place the face cap back in the filter holder and place the small plugs in both the inlet and outlet of the filter holder.
7. With each batch of samples, submit one filter subjected to exactly the same handling except that no air is drawn through it. Label it as a blank.

Special Considerations:

1. A high fiber count on blank filters reduces the accuracy and precision of the method.
2. The filters on which the samples are collected and the blank filters should all come from the same batch since the background dust count will vary from batch to batch.

Shipping Instructions:

Ship in a container designed to prevent damage during transit.

References:

Leidel, N., "Optimum Sampling Times for Airborne Asbestos Fibers." -72, NIOSH Engineering Branch, November 1972, 6 pp.

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container that will be sent to an approved asbestos landfill site. Alternatively, the area may be washed into a waste asbestos collection system or the asbestos wetted down and picked up.

It is suggested that a periodic inspection of the storage area be made by a supervisor and that immediate action be taken to prevent or reduce the possibility of airborne asbestos fiber.

4.5 USING-DIAPHRAGM DEPOSITING

A potential exposure to asbestos in chlor-alkali operations occurs when it is being prepared for use in making diaphragms.

When handling industrial bags from storage to point of use, care should be taken to be sure that the bag is not split or open. A supply of large heavy duty plastic bags should be available for containing any broken bags before movement is allowed to take place. Those employees working in direct contact with asbestos should wear an approved dust mask and appropriate protective clothing.

Bags of asbestos to be added to the diaphragm bath should be moved carefully to prevent or minimize any dust emission that may arise. Bags should never be thrown or dropped as this will result in asbestos contamination of the air.

There are a variety of safe ways of handling dry asbestos in preparing for diaphragm depositing operations. Regardless of the approach used, it is imperative that emissions of dry asbestos in the worker breathing zone or to the ambient air be controlled to within regulatory limitations. The mere weighing and dumping of asbestos into a depositing bath without benefit of a vacuum venting system to contain and trap asbestos dust should be avoided. As a minimum, asbestos bag cutting, emptying, sorting, weighing and slurry preparation should be performed under a vented hood; see Figure 1. A more sophisticated approach would be to perform such operations in a tightly sealed, vented enclosure into which the operator inserts his hands in gloves fastened to the inside of the enclosure.

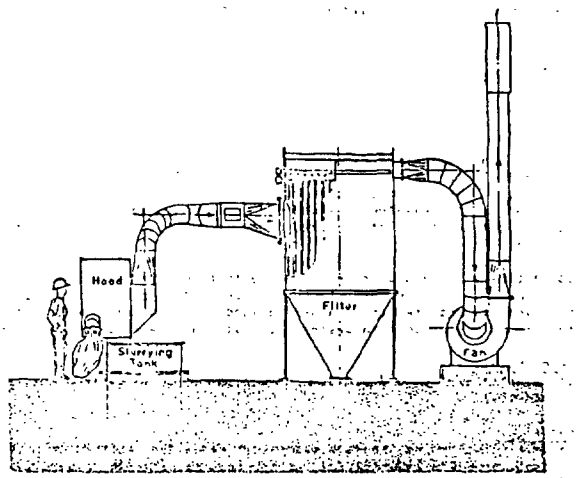

FIGURE 1. ASBESTOS DUST COLLECTOR

Written detailed operating procedures should be available to workers and it should be determined they are being followed. These should include information as to the types of protective clothing and masks to be worn, including their ultimate disposal; checking of vacuum and exhaust system; details of slurry make-up operations; shut-down and housekeeping procedures etc.

4.5.1 Sorting and Weighing

Greatest care should be exercised in opening asbestos bags, especially if not done within a sealed system. A suggested technique is to use a heated knife to cut the bags. Bags should be fully slit, always under a vacuum vent system, and carefully folded over to allow emptying of the bag with a minimum disturbance of the contents. Bags should never be shaken. Any necessary de-lumping of asbestos similarly should be done cautiously to minimize dust release.

Empty bags should be carefully folded with slit area inside, again within the sealed or vacuum vent system. Within that system they should be deposited in a lidded, labeled container reserved for the purpose or placed in a labeled, plastic bag that is tied or otherwise fastened shut.

When only partial contents of a bag is required, the bag should be resealed effectively, such as with wide duct tape, to contain the remaining asbestos.

Weighing of asbestos should be done, again within a sealed or vacuum vent system, in such a manner as to minimize dust release. The same applies to preparation of the asbestos slurry. Containers of weighed asbestos must have a lid in place as soon as the proper weight is obtained.

4.5.2 Protective Equipment
Workers involved in asbestos bag transfer and slitting, sorting, weighing, and slurry-preparation operations should wear an approved mask or respirator as well as suitable protective clothing.

4.5.3 Housekeeping
Upon completion of operations any asbestos fibers should be removed, such as by a vacuum hose. The work area should then be carefully flushed down with water; hitting dried asbestos with high/medium pressure water might cause some of it to become airborne.

4.5.4 Personal Hygiene
Used dust masks, gloves, and other protective clothing should be removed and placed in the labeled receptacle(s) set aside for the purpose, and the receptacle then should be closed or otherwise fastened. Non-disposable protective clothing should be inspected and any fibers vacuum-removed; clothing should not be air blown, shaken or brushed for this purpose. Workers should wash hands and face before leaving asbestos-contaminated areas.

4.6 SPENT ASBESTOS

4.6.1 Wash Area
Asbestos diaphragms need be removed and replaced at some frequency depending on cell type, brine quality, and other variables.

The wash area should be constructed with a smooth surface to prevent asbestos from adhering and drying, and from becoming a possible source of airborne asbestos. The area should also contain a trench system for receiving and carrying away the asbestos to a sump or pit. If possible, some sort of minimum sloping of the concrete floor should be used to facilitate drainage. The collection trench should be covered with removable type grating to allow for ease of clean-up.

After use of the wash area and at the end of each work day, all areas should be carefully flushed to remove all traces of asbestos. If water use is a problem the area can be initially cleaned using a large rubber squeegie; final wash down then can be accomplished with a minimum quantity of water.

4.6.2 Disposal
As is the case with diaphragm depositing operations, there are several alternate ways of safely disposing of spent asbestos. Separation of spent asbestos from the diaphragm wash generally is accomplished by approved pond settling or by filtering, such as in plate and frame filters. The system chosen will depend largely on the availability of space and its optimum utilization.

Ponding and settling of asbestos-containing cell renewal wastes can be facilitated by the addition of a polyelectrolyte flocculant. Pond size will, of course, depend on the volume of waste to be handled, climatic conditions, etc. Ponds will require occasional clean-out of settled materials; this can be accomplished by a carefully-planned clam shell bucket transfer operation with the solids being emptied into covered, water-tight trucks for transfer to an approved landfill disposal site.

Conventional plate and frame filters effectively remove asbestos particles* and require regular maintenance. Filtered asbestos should be deposited into a suitable water-tight, covered container, for eventual transfer to an approved landfill disposal site. Such containers should be kept wetted to prevent any airborne asbestos and must bear the required OSHA caution label.

4.6.3 Water Re-Use
If water reuse from a diaphragm renewal operation is contemplated, some treatment prior to use may be necessary .

4.6.4 Landfills
Landfills into which asbestos wastes are deposited, whether on or off-premises, are strictly controlled by EPA [40CFR61.25], as are reports perteing to same [40CFR61.24]. Transportation of wastes to contract disposal sites must be accomplished in accord with any applicable regulations.

5. EMPLOYEE PROTECTION

5.1 GENERAL

Asbestos can cause serious health probelms unless it is properly used and handled. Excessive exposure to asbestos dust can cause human disease, specifically pulmonary fibrosis, carcinoma and pleural mesothelioma. The qualification of the health risk associated with specific airborne concentrations, fiber dimensions, and the chemical composition of the fibers, however, is inexact. In addition the problem of estimating the magnitude of the risk is complicated by the 20- to 40-year latency period between the onsat of exposure and the appearance of disease. Consequently, human exposure must be reduced to within allowable exposure levels.

Regulations require that engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, be employed to meet the limiting TWA and ceiling level exposure concentrations [29CFR1910.1001(c)]. They also require, insofar as practicable, that asbestos be handled, mixed, applied, removed etc. in a wet state sufficient to prevent the emission of airborne fibers in excess of the limiting worker exposure concentrations. Compliance

* While filters are effective for asbestos particles or bundles, it has been suggested that they are not effective on small fibrils.

may not be achieved by the use of respirators or shift rotations except in those work situations where (a) prescribed engineering control methods and/or work practices are technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below permissible TWA and ceiling concentrations, and (b) during emergencies; in those instances, and where both respirators and personnel rotation are practicable, personnel rotation shall be preferred and used [29CFR1910.1001(d)].

5.2 CAUTION SIGNS AND LABELS

Caution signs must be provided and displayed at each location where airborne concentrations of asbestos may exceed limiting worker exposure concentrations [29CFR1910.1001(g)(1)] and at and around asbestos waste disposal sites [40CFR61.22(1)]. The signs must be of such dimensions and posted in such a manner that a person may easily read them and take necessary precautions and protective measures before entering the area marked [29CFR1910.1001(g)(1) and 40CFR61.22(1)(2)]. It is recommended that caution signs be posted wherever asbestos is handled or used.

Caution labels must be affixed to all raw materials, mixtures, scraps, waste, debris etc. containing unbonded asbestos, or to their containers [29CFR1910.1001(g)(2)], including sealed, leak-tight containers of asbestos-containing wastes (e.g. empty bags, dust masks, disposable clothing, sludges etc.) destined for ultimate disposal at approved landfill sites [40CFR61.22(j)].

5.3 RESPIRATORS

Where use of respirators are permitted they must be selected from those approved by either the U.S. Bureau of Mines or NIOSH/Mining Enforcement and Safety Administration [29CFR1910.1001(d)(2)] (See Ref. §8.1.1) or other appropriate approving authority.

OSHA General Industry Standards on Respiratory Protection [29CFR1910.1001.134] require that a respiratory protective program be established by the employer and that the respiratory protective equipment used be effective. (See also 29CFR1910.1001(d)(2).

It is recommended that employees wear an approved dust respirator whenever there exists a good possibility of exposure in excess of allowable standards. This is especially applicable when performing maintenance work on dust collector components.

5.4 PROTECTIVE CLOTHING

Regulations require that workers exposed to asbestos in excess of the allowable ceiling concentration of 10 fibers/cc wear protective clothing such as overalls or similar whole body clothing, head coverings, gloves and foot coverings; such clothing must be employer-provided [29CFR1910.1001(d)(3)]. It is recommended that protective clothing contain no pockets or side openings.

Employers also are obligated to provide change rooms for workers in situations where workers may be exposed to asbestos fiber in excess of the allowable TWA and ceiling concentrations, and two separate lockers or other containers for each worker so separated or isolated as to prevent contamination of the worker's street clothes from his work clothes[29CFR1910.1001(d)(4)].

Many employers prefer to provide disposable-type overalls although reusable ones are permitted. In the latter case, anti-static, cotton polyester fabric of fine weave has proven highly satisfactory. Laundering, whether on or off premises, should be done in such a way as to prevent airborne contamination in excess of allowable limits. Where contract laundering exists, it is incumbent on the employer to inform the launderer (preferably in writing) of this obligation [29CFR1910.1001(d)(4)]; it is also recommended that the operation be inspected on a periodic basis.

Soiled protective clothing, whether of the reusable or disposable type, should be placed in sealed, impermeable bags or other closed, impermeable containers which must bear the required caution label [29CFR1910.1001(d)(4)(iii)]; [40CFR61.22(j)]. Use of water-soluble laundry bags, if available, would minimize exposure potential in handling operations.

It is recommended that protective clothing be issued and collected on a daily basis.

Soiled disposable type protective clothing should be considered to be contaminated with asbestos and, therefore, disposal must be in accord with EPA regulations [40CFR61.22]. Reusable clothing should be vacuum-cleaned prior to placing in containers for laundering; they should not be shaken, brushed, or air blown.

5.5. HOUSEKEEPING

All external surfaces in any place of employment must be maintained free of accumulations of asbestos fiber, if with their dispersion, there would be an excessive concentration [29CFR1910.1001(h)]. This can be accomplished with the use of a controlled central vacuum system or disposable-bag vacuum cleaner designed so that there is no discharge of asbestos from the filter.

6. MONITORING

Prescribed monitoring involves both industrial hygiene sampling and medical surveillance programs.

6.1 HYGIENE MONITORING

Both personal and environmental monitoring are prescribed. The sampling frequency and patterns must be such as to represent with reasonable accuracy the worker's exposure levels. For workers whose exposure to asbestos may reasonably be forseen to exceed the limiting TWA and ceiling concentrations, the intervals must not exceed six months [29CFR1910.1001 (f)]. Workers or their representatives must be given opportunity to observe any required monitoring, as well as access to results of same.

6.1.1 Personal Monitoring
Samples for determination of both TWA and ceiling asbestos concentrations must be taken within the worker's breathing zone; See Figure 2.

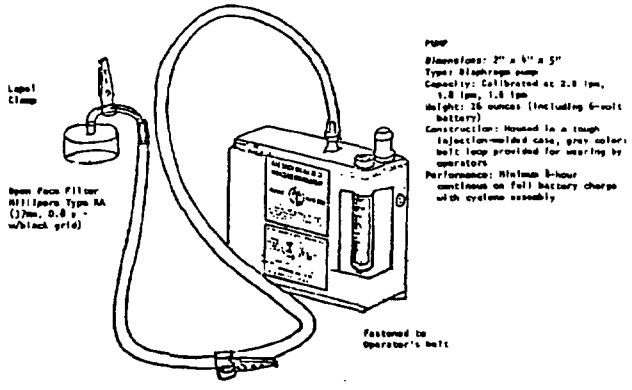

FIGURE 2. ASBESTOS SAMPLER

6.1.2 Environmental Monitoring
Samples must be collected from areas of a work environment that are representative of airborne concentrations of asbestos which may reach workers breathing zones.

6.1.3 Records
Environmental and personal monitoring records required by OSHA regulations must be maintained for a minimum of 20 years and, upon request, must be made available to OSHA and NIOSH authorities and their authorized representatives [29CFR1910.1001(i)].

6.1.4 Employee Access and Notification
Present and past employees are guaranteed right of access to hygiene monitoring records pertaining to their individual asbestos exposure. Employees exposed to asbestos in excess of limiting TWA and ceiling concentrations must be notified within five days of the finding and of corrective action being taken [29CFR1910.1001(i)(2) and (3)]. It is recommended that records be kept of any such notifications.

6.2 MEDICAL SURVEILLANCE
OSHA regulations [29CFR1910.1001(j)(3)] provide for medical surveillance of workers "engaged in any occupations exposed to airborne concentrations of asbestos fibers." Required medical examinations must be *provided, or made available, by the employer.**

6.2.1 Pre-Placement
A comprehensive medical examination is required within 30 days of a worker's assignment to an occupation involving exposure to airborne asbestos. As a minimum the examination shall include:

*Chest roentgenogram (Posterior-Anterior, 14" x 17")

*History, to elicit symptomotology of respiratory disease

*Pulmonary function tests, including forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$)

In addition, it is recommended that a complete smoking history should be recorded, including average daily consumption. The examining physician shall make a determination of the ability of the worker to effectively wear a respirator.

6.2.2 Periodic
Regulations require that employer's provide or make available a comprehensive medical examination at least annually and including, as a minimum, those elements listed in §6.2.1.

6.2.3 Termination
Regulations require that employers provide or make available a comprehensive medical examination within 30 days before or after termination of employment including, as a minimum, those elements listed in §6.2.1.

6.2.4 Record Retention
Employers are obligated to maintain all medical records for a minimum of 20 years.

* An administrative interpretation is provided in OSHA Program Directive #300-16 (10/11/78); the term "exposed to airborne concentrations of asbestos fiber" is interpreted to mean "exposed to a minimum of 0.1 asbestos fibers larger than 5 micrometers per cubic centimeter of air." Also, that medical examinations are required for any 7 to 8-hour time-weighted average concentration of 0.1 f/cc, or for a greater concentration.

8. REFERENCES

8.1 DHEW (U.S.)

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8.1.2 "Criteria for a Recommended Standard: Occupational Exposure to Asbestos," Report HSM72-10267 (1972). Available from U.S. Government Printing Office, Washington, D.C. 20402

8.1.3 "NIOSH Manual of Sampling Data Sheets - 1977 Edition". Available from DHEW, Center for Disease Control, Cincinnati, OH 45226

8.1.4 "NIOSH Revised Recommended Asbestos Standard," DHEW Publication 77-169 (December 1976). Available from U.S. Government Printing Office, Washington, D.C. 20402

8.1.5 "Membrane Filter Method for Evaluating Airborne Asbestos Fibers," NIOSH Publication TR84 (1976). Available from the U.S. Government Printing Office, Washington, D.C. 20402

8.2 EPA (U.S.)

8.2.1 "Electron Microscope Measurement of Airborne Asbestos Concentrations, A Provisional Methodology Manual," EPA Report 600/2-77-178 (June, 1978). Available from EPA Office of Research and Development, Research Triangle Park, NC 27711.

8.2.2 "Evaluating and Optimizing Electron Microscope Methods for Characterizing Airborne Asbestos," EPA Report 600/2-78-038 (June, 1978)." Available from EPA Office of Research and Development, Research Triangle Park, NC 27711.

8.2.3 "Preparation of Water Samples for Asbestos Fiber Counting by Electron Microscopy," EPA Report 600/4-78-011 (January, 1978). Available from EPA Office of Research and Development, Athens, GA 30601.

8.3 MISCELLANEOUS

8.3.1 "Measurement of Asbestos Exposure," J. Occupational Medicine 10:1, 21 (January 1968).

8.3.2 "Asbestos: An Information Resource," DHEW Publication (NIH) 78-1681 (May 1978). Available from office of Cancer Communications, National Cancer Institute, Bethesda, MD 20014

8.4 OTHER INFORMATION SOURCES

8.4.1 Asbestos Information Association, 1745 Jefferson Davis Highway, Crystal Square 4, Arlington, VA 22202

8.4.2 Johns Manville Corporation, Environmental Affairs Department, P O Box 5108, Denver, CO 80217

9. APPENDICES

9.1 ANALYTICAL METHODS

9.1.1 EPA Method for Asbestos in Water

9.1.2 NIOSH Sampling Data Sheet #2.02 (Sept. 4, 1975)

9.2 REGULATIONS

9.2.1 DOT : 49 CFR Parts 172 - 177

9.2.2 EPA : 40 CFR Part 61

9.2.3 DOL-OSHA : 29 CFR 1910.1001