

Appendix A1. Occupational Safety and Health Administration (OSHA) Asbestos Regulations for the Construction Industry (29 CFR 1926.58)

§ 1926.58 Asbestos, tremolite, anthophyllite, and actinolite.

(a) *Scope and application.* This section applies to all construction work as defined in 29 CFR 1910.12(b), including but not limited to the following:

(1) Demolition or salvage of structures where asbestos, tremolite, anthophyllite, or actinolite is present;

(2) Removal or encapsulation of materials containing asbestos, tremolite, anthophyllite, or actinolite;

(3) Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos, tremolite, anthophyllite, or actinolite;

(4) Installation of products containing asbestos, tremolite, anthophyllite, or actinolite;

(5) Asbestos, tremolite, anthophyllite, and actinolite spill/emergency cleanup; and

(6) Transportation, disposal, storage, or containment of asbestos, tremolite, anthophyllite, or actinolite or products containing asbestos, tremolite, anthophyllite, or actinolite on the site or location at which construction activities are performed.

(b) *Definitions.* "Action level" means an airborne concentration of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals of 0.1 fiber per cubic centimeter (f/cc) of air calculated as an eight (8)-hour time-weighted average.

"Asbestos" includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that has been chemically treated and/or altered.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee

"Authorized person" means any person authorized by the employer and required by work duties to be present in regulated areas.

"Clean room" means an uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.

"Competent person" means one who is capable of identifying existing asbestos, tremolite, anthophyllite, or actinolite hazards in the workplace and who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f). The

duties of the competent person include at least the following: establishing the negative-pressure enclosure, ensuring its integrity, and controlling entry to and exit from the enclosure; supervising any employee exposure monitoring required by the standard; ensuring that all employees working within such an enclosure wear the appropriate personal protective equipment, are trained in the use of appropriate methods of exposure control, and use the hygiene facilities and decontamination procedures specified in the standard; and ensuring that engineering controls in use are in proper operating condition and are functioning properly.

"Decontamination area" means an enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment contaminated with asbestos, tremolite, anthophyllite, or actinolite.

"Demolition" means the wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos, tremolite, anthophyllite, or actinolite products.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee.

"Employee exposure" means that exposure to airborne asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals, that would occur if the employee were not using respiratory protective equipment.

"Equipment room (change room)" means a contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.

"Fiber" means a particulate form of asbestos, tremolite, anthophyllite, or actinolite, 5 micrometers or longer, with a length-to-diameter ratio of at least 3 to 1.

"High-efficiency particulate air (HEPA) filter" means a filter capable of trapping and retaining at least 99.97 percent of all monodispersed particles of 0.3 micrometers in diameter or larger.

"Regulated area" means an area established by the employer to demarcate areas where airborne

concentrations of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals exceed or can reasonably be expected to exceed the permissible exposure limit. The regulated area may take the form of (1) a temporary enclosure, as required by paragraph (e)(6) of this section, or (2) an area demarcated in any manner that minimizes the number of employees exposed to asbestos, tremolite, anthophyllite, or actinolite.

"Removal" means the taking out or stripping of asbestos, tremolite, anthophyllite, or actinolite or materials containing asbestos, tremolite, anthophyllite, or actinolite.

"Renovation" means the modifying of any existing structure, or portion thereof, where exposure to airborne asbestos, tremolite, anthophyllite, actinolite may result.

"Repair" means overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates where asbestos, tremolite, anthophyllite, or actinolite is present.

"Tremolite, anthophyllite and actinolite" means the non-asbestos form of these minerals, and any of these minerals that have been chemically treated and/or altered.

(c) *Permissible exposure limit (PEL).* The employer shall ensure that no employee is exposed to an airborne concentration of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals in excess of 0.2 fiber per cubic centimeter of air as an eight (8) hour time-weighted average (TWA), as determined by the method prescribed in Appendix A of this section, or by an equivalent method.

(d) *Communication among employers.* On multi-employer worksites, an employer performing asbestos, tremolite, anthophyllite, or actinolite work requiring the establishment of a regulated area shall inform other employers on the site of the nature of the employer's work with asbestos, tremolite, anthophyllite, or actinolite and of the existence of and requirements pertaining to regulated areas.

(e) *Regulated areas—(1) General.* The employer shall establish a regulated area in work areas where airborne concentrations of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals exceed or can reasonably be expected to exceed the permissible exposure limit prescribed in paragraph (c) of this

at a centrally located place that is accessible to affected employees.

(7) *Observation of monitoring.* (i) The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to asbestos, tremolite, anthophyllite, or actinolite conducted in accordance with this section.

(ii) When observation of the monitoring of employee exposure to asbestos, tremolite, anthophyllite, or actinolite requires entry into an area where the use of protective clothing or equipment is required, the observer shall be provided with and be required to use such clothing and equipment and shall comply with all other applicable safety and health procedures.

(g) *Methods of compliance.*—(1) *Engineering controls and work practices.* (i) The employer shall use one or any combination of the following control methods to achieve compliance with the permissible exposure limit prescribed by paragraph (c) of this section:

(A) Local exhaust ventilation equipped with HEPA filter dust collection systems;

(B) General ventilation systems;

(C) Vacuum cleaners equipped with HEPA filters;

(D) Enclosure or isolation of processes producing asbestos, tremolite, anthophyllite, or actinolite dust;

(E) Use of wet methods, wetting agents, or removal encapsulants to control employee exposures during asbestos, tremolite, anthophyllite, or actinolite handling, mixing, removal, cutting, application, and cleanup;

(F) Prompt disposal of wastes contaminated with asbestos, tremolite, anthophyllite, or actinolite in leak-tight containers; or

(G) Use of work practices or other engineering controls that the Assistant Secretary can show to be feasible.

(ii) Wherever the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the limit prescribed in paragraph (c), the employer shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (h) of this section.

(2) *Prohibitions.* (i) High-speed abrasive disc saws that are not equipped with appropriate engineering controls shall not be used for work related to asbestos, tremolite, anthophyllite, or actinolite.

(ii) Compressed air shall not be used to remove asbestos, tremolite, anthophyllite, or actinolite or materials containing asbestos, tremolite, anthophyllite, or actinolite unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

(iii) Materials containing asbestos, tremolite, anthophyllite, or actinolite shall not be applied by spray methods.

(3) *Employee rotation.* The employer shall not use employee rotation as a means of compliance with the exposure limit prescribed in paragraph (c) of this section.

(h) *Respiratory protection.*—(1) *General.* The employer shall provide respirators, and ensure that they are used, where required by this section. Respirators shall be used in the following circumstances:

(i) During the interval necessary to install or implement feasible engineering and work practice controls;

(ii) In work operations such as maintenance and repair activities, or other activities for which engineering and work practice controls are not feasible;

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the exposure limit; and

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are used, the employer shall select and provide, at no cost to the employee, the appropriate respirator as specified in Table D-4, and shall ensure

TABLE D-4.—RESPIRATORY PROTECTION FOR ASBESTOS, TREMOLITE, ANTHOPHYLLITE, AND ACTINOLITE FIBERS

Airborne concentration of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals	Required respirator
Not in excess of 2 f/cc (10 X PEL).	1 Half-mask air-purifying respirator equipped with high-efficiency filters.
Not in excess of 10 f/cc (50 X PEL)	1 Full facepiece air-purifying respirator equipped with high-efficiency filters
Not in excess of 20 f/cc (100 X PEL)	1 Any powered air purifying respirator equipped with high efficiency filters 2 Any supplied-air respirator operated in continuous flow mode
Not in excess of 200 f/cc (1000 X PEL)	1 Full facepiece supplied-air respirator operated in pressure demand mode.
Greater than 200 f/cc (> 1,000 X PEL) or unknown concentration	1 Full facepiece supplied air respirator operated in pressure demand mode equipped with an auxiliary positive pressure self-contained breathing apparatus.

NOTE. a. Respirators assigned for higher environmental concentrations may be used at lower concentrations.

b. A high-efficiency filter means a filter that is at least 99.97 percent efficient against mono-dispersed particles of 0.3 micrometers in diameter or larger.

that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those jointly approved as being acceptable for protection by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(iii) The employer shall provide a powered, air-purifying respirator in lieu of any negative-pressure respirator specified in Table D-4 whenever:

(A) An employee chooses to use this type of respirator; and

(B) This respirator will provide adequate protection to the employee.

(3) *Respirator program.* (i) Where respiratory protection is used, the employer shall institute a respirator program in accordance with 29 CFR 1910.134(b), (d), (e), and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their faces and respirator facepieces whenever necessary to prevent skin irritation associated with respirator use.

(iv) No employee shall be assigned to tasks requiring the use of respirators if, based on his or her 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 of other employees will be impaired by the use of a respirator. Such employee shall be assigned to another job or given the opportunity to transfer to a different position the duties of which he or she is able to perform with the same employer, in the same geographical area, and with the same seniority, status, and rate of pay he or she had just prior to such transfer, if such a different position is available.

(4) *Respirator fit testing.* (i) The employer shall ensure that the respirator issued to the employee exhibits the least possible facepiece leakage and that the respirator is fitted properly.

(ii) Employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every 6 months thereafter for each employee wearing a negative-pressure respirator. The qualitative fit tests may be used only for testing the fit of half-

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(iii) Where minerals in the regulated area are only tremolite, anthophyllite or actinolite, the employer may replace the term "asbestos" with the appropriate mineral name.

(2) *Labels.* (i) Labels shall be affixed to all products containing asbestos, tremolite, anthophyllite, or actinolite and to all containers containing such products, including waste containers. Where feasible, installed asbestos, tremolite, anthophyllite, or actinolite products shall contain a visible label.

(ii) Labels shall be printed in large, bold letters on a contrasting background.

(iii) Labels shall be used in accordance with the requirements of 29 CFR 1910.1200(f) of OSHA's Hazard Communication standard, and shall contain the following information:

DANGER

CONTAINS ASBESTOS FIBERS

AVOID CREATING DUST

CANCER AND LUNG DISEASE

HAZARD

(iv) Where minerals to be labeled are only tremolite, anthophyllite and actinolite, the employer may replace the term "asbestos" with the appropriate mineral name.

(v) Labels shall contain a warning statement against breathing airborne asbestos, tremolite, anthophyllite, or actinolite fibers.

(vi) The provisions for labels required by paragraphs (k)(2)(i)-(k)(2)(iv) do not apply where:

(A) asbestos, tremolite, anthophyllite, or actinolite fibers have been modified by a bonding agent, coating, binder, or other material, provided that the manufacturer can demonstrate that, during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos, tremolite, anthophyllite, actinolite, or a combination of these mineral fibers in excess of the action level will be released, or

(B) asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals is present in a product in concentrations less than 0.1 percent by weight.

(3) *Employee information and training.* (i) The employer shall institute a training program for all employees exposed to airborne concentrations of asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals at or above the action level and shall ensure their participation in the program.

(ii) Training shall be provided prior to or at the time of initial assignment, unless the employee has received equivalent training within the previous 12 months, and at least annually thereafter.

(iii) The training program shall be conducted in a manner that the employee is able to understand. The employer shall ensure that each such employee is informed of the following:

(A) Methods of recognizing asbestos, tremolite, anthophyllite, and actinolite;

(B) The health effects associated with asbestos, tremolite, anthophyllite, or actinolite exposure;

(C) The relationship between smoking and asbestos, tremolite, anthophyllite, and actinolite in producing lung cancer;

(D) The nature of operations that could result in exposure to asbestos, tremolite, anthophyllite, and actinolite, the importance of necessary protective controls to minimize exposure including, as applicable, engineering controls, work practices, respirators, housekeeping procedures, hygiene facilities, protective clothing, decontamination procedures, emergency procedures, and waste disposal procedures, and any necessary instruction in the use of these controls and procedures;

(E) The purpose, proper use, fitting instructions, and limitations of respirators as required by 29 CFR 1910.134;

(F) The appropriate work practices for performing the asbestos, tremolite, anthophyllite, or actinolite job; and

(G) Medical surveillance program requirements.

(H) A review of this standard, including appendices.

(4) *Access to training materials.* (i) The employer shall make readily available to all affected employees without cost all written materials relating to the employee training program, including a copy of this regulation.

(ii) The employer shall provide to the Assistant Secretary and the Director, upon request, all information and training materials relating to the employee information and training program.

(I) *Housekeeping*—(1) *Vacuuming.* Where vacuuming methods are selected, HEPA filtered vacuuming equipment must be used. The equipment shall be used and emptied in a manner that minimizes the reentry of asbestos, tremolite, anthophyllite, or actinolite into the workplace.

(2) *Waste disposal.* Asbestos waste, scrap, debris, bags, containers, equipment, and contaminated clothing consigned for disposal shall be collected and disposed of in sealed, labeled, impermeable bags or other closed, labeled, impermeable containers.

(m) *Medical surveillance*—(1) *General*—(i) *Employees covered.* The employer shall institute a medical surveillance program for all employees engaged in work involving levels of asbestos, tremolite, anthophyllite, actinolite or a combination of these minerals, at or above the action level for 30 or more days per year, or who are required by this section to wear negative pressure respirators.

(ii) *Examination by a physician.* (A) The employer shall ensure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided at no cost to the employee and at a reasonable time and place.

(B) Persons other than such licensed physicians who administer the pulmonary function testing required by this section shall complete a training course in spirometry sponsored by an appropriate academic or professional institution.

(2) *Medical examinations and consultations*—(i) *Frequency.* The employer shall make available medical examinations and consultations to each employee covered under paragraph (m)(1)(i) of this section on the following schedules:

(A) Prior to assignment of the employee to an area where negative-pressure respirators are worn;

(B) When the employee is assigned to an area where exposure to asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals may be at or above the action level for 30 or more days per year, a medical examination must be given within 10 working days following the thirtieth day of exposure;

(C) And at least annually thereafter.

(D) If the examining physician determines that any of the examinations should be provided more frequently than specified, the employer shall provide such examinations to affected employees at the frequencies specified by the physician.

(E) *Exception:* 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.

(ii) *Content.* Medical examinations

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make employee medical records required by paragraphs (m) and (n) of this section available for examination and copying to the subject employee, anyone having the specific written consent of the subject employee, and the Assistant Secretary, in accordance with 29 CFR 1910.20.

(6) *Transfer of records.* (i) The employer shall comply with the requirements concerning transfer of records set forth in 29 CFR 1910.20 (h).

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall notify the Director at least 90 days prior to disposal and, upon request, transmit them to the Director.

(c) *Dates—(1) Effective date.* This section shall become effective [insert date 30 days from publication in the **Federal Register**]. The requirements of the asbestos standard issued in June 1972 (37 FR 11318), as amended, and published in 29 CFR 1910.1001 (1985) remain in effect until compliance is achieved with the parallel provisions of this standard.

(2) *Start-up dates.* (i) The requirements of paragraphs (c) through (n) of this section, including the engineering controls specified in paragraph (g)(1) of this section, shall be complied with by [insert date 210 days from publication in the **Federal Register**].

(p) *Appendices.* (1) Appendices A, C, D, and E to this section are incorporated as part of this section and the contents of these appendices are mandatory.

(2) Appendices B, F, G, H, and I to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

Appendix A to §1926.58—Osha Reference Method—Mandatory

This mandatory appendix specifies the procedure for analyzing air samples for asbestos, tremolite, anthophyllite, and actinolite and specifies quality control procedures that must be implemented by laboratories performing the analysis. The sampling and analytical methods described below represent the elements of the available monitoring methods (such as the NIOSH 7400 method) which OSHA considers to be essential to achieve adequate employee exposure monitoring while allowing employers to use methods that are already established within their organizations. All employers who are required to conduct air monitoring under paragraph (f) of the standard are required to utilize analytical laboratories that use this procedure, or an equivalent method, for collecting and

analyzing samples.

Sampling and Analytical Procedure

1. The sampling medium for air samples shall be mixed cellulose ester filter membranes. These shall be designated by the manufacturer as suitable for asbestos, tremolite, anthophyllite, and actinolite counting. See below for rejection of blanks.

2. The preferred collection device shall be the 25-mm diameter cassette with an open-faced 50-mm extension cowl. The 37-mm cassette may be used if necessary but only if written justification for the need to use the 37-mm filter cassette accompanies the sample results in the employee's exposure monitoring record.

3. An air flow rate between 0.5 liter/min and 2.5 liters/min shall be selected for the 25-mm cassette. If the 37-mm cassette is used, an air flow rate between 1 liter/min and 2.5 liters/min shall be selected.

4. Where possible, a sufficient air volume for each air sample shall be collected to yield between 100 and 1,300 fibers per square millimeter on the membrane filter. If a filter darkens in appearance or if loose dust is seen on the filter, a second sample shall be started.

5. Ship the samples in a rigid container with sufficient packing material to prevent dislodging the collected fibers. Packing material that has a high electrostatic charge on its surface (e.g., expanded polystyrene) cannot be used because such material can cause loss of fibers to the sides of the cassette.

6. Calibrate each personal sampling pump before and after use with a representative filter cassette installed between the pump and the calibration devices.

7. Personal samples shall be taken in the "breathing zone" of the employee (i.e., attached to or near the collar or lapel near the worker's face).

8. Fiber counts shall be made by positive phase contrast using a microscope with an 8 to 10 X eyepiece and a 40 to 45 X objective for a total magnification of approximately 400 X and a numerical aperture of 0.65 to 0.75. The microscope shall also be fitted with a green or blue filter.

9. The microscope shall be fitted with a Walton-Beckett eyepiece graticule calibrated for a field diameter of 100 micrometers (+/- 2 micrometers).

10. The phase-shift detection limit of the microscope shall be about 3 degrees measured using the HSE phase shift test slide as outlined below.

a. Place the test slide on the microscope stage and center it under the phase objective.

b. Bring the blocks of grooved lines into focus.

Note.—The slide consists of seven sets of grooved lines (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7, seven being the least visible. The requirements for asbestos, tremolite, anthophyllite, and actinolite counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least

partially visible but may vary slightly in visibility between microscopes. A microscope that fails to meet these requirements has either too low or too high a resolution to be used for asbestos, tremolite, anthophyllite, and actinolite counting.

c. If the image deteriorates, clean and adjust the microscope optics. If the problem persists, consult the microscope manufacturer.

11. Each set of samples taken will include 10 percent blanks or a minimum of 2 blanks. The blank results shall be averaged and subtracted from the analytical results before reporting. Any samples represented by a blank having a fiber count in excess of 7 fibers/100 fields shall be rejected.

12. The samples shall be mounted by the acetone/triacetin method or a method with an equivalent index of refraction and similar clarity.

13. Observe the following counting rules.

a. Count only fibers equal to or longer than 5 micrometers. Measure the length of curved fibers along the curve.

b. Count all particles as asbestos, tremolite, anthophyllite, and actinolite that have a length-to-width ratio (aspect ratio) of 3:1 or greater.

c. Fibers lying entirely within the boundary of the Walton-Beckett graticule field shall receive a count of 1. Fibers crossing the boundary once, having one end within the circle, shall receive the count of one half (½). Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may be visible outside the graticule area.

d. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of an individual fiber.

e. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields; stop counting at 100 fields regardless of fiber count.

14. Blind recounts shall be conducted at the rate of 10 percent.

Quality Control Procedures

1. **Intralaboratory program.** Each laboratory and/or each company with more than one microscopist counting slides shall establish a statistically designed quality assurance program involving blind recounts and comparisons between microscopists to monitor the variability of counting by each microscopist and between microscopists. In a company with more than one laboratory, the program shall include all laboratories and shall also evaluate the laboratory-to-laboratory variability.

2. **Interlaboratory program.** Each laboratory analyzing asbestos, tremolite, anthophyllite, and actinolite samples for compliance determination shall implement an interlaboratory quality assurance program that as a minimum includes participation of at least two other independent laboratories. Each laboratory shall participate in round robin testing at least once every 6 months with at least all the other laboratories in its interlaboratory quality assurance group. Each

the glass slide gently in the vapor stream. The filter should clear in 2 to 5 sec. If the filter curls, distorts, or is otherwise rendered unusable, the vapor stream is probably not strong enough. Periodically wipe the outlet port with tissue to prevent liquid acetone dripping onto the filter.

d. Using the hypodermic syringe with a 22-gauge needle, place 1 to 2 drops of triacetin on the filter. Gently lower a clean 25-mm square cover slip down onto the filter at a slight angle to reduce the possibility of forming bubbles. If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours.

e. Glue the edges of the cover slip to the glass slide using a lacquer or nail polish.

Note.—If clearing is slow, the slide preparation may be heated on a hotplate (surface temperature 50 °C) for 15 min to hasten clearing. Counting may proceed immediately after clearing and mounting are completed.

Calibration and Quality Control

11. Calibration of the Walton-Beckett graticule. The diameter, d_c (mm), of the circular counting area and the disc diameter must be specified when ordering the graticule.

a. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.

b. Set the appropriate interpupillary distance and, if applicable, reset the binocular head adjustment so that the magnification remains constant.

c. Install the 40 to 45 × phase objective.

d. Place a stage micrometer on the microscope object stage and focus the microscope on the graduate lines.

e. Measure the magnified grid length, L_o (mm), using the stage micrometer.

f. Remove the graticule from the microscope and measure its actual grid length, L_a (mm). This can best be accomplished by using a stage fitted with verniers.

g. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a \times D}{L_o}$$

Example.—If $L_o = 108$ μ m, $L_a = 2.93$ mm and $D = 100$ μ m, then $d_c = 2.71$ mm.

h. Check the field diameter, D (acceptable range 100 mm $\pm$ 2 mm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (mm²).

12. Microscope adjustments. Follow the manufacturer's instructions and also the following:

a. Adjust the light source for even illumination across the field of view at the condenser iris.

Note.—Kohler illumination is preferred, where available.

b. Focus on the particulate material to be examined.

c. Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.

d. Use the telescope ocular supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric.

13. Check the phase-shift detection limit of the microscope periodically.

a. Remove the HSE/NPL phase-contrast test slide from its shipping container and center it under the phase objective.

b. Bring the blocks of grooved lines into focus.

Note.—The slide consists of seven sets of grooves (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7. The requirements for counting are that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 to 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has either too low or too high a resolution to be used for asbestos, tremolite, anthophyllite, and actinolite counting.

c. If the image quality deteriorates, clean the microscope optics and, if the problem persists, consult the microscope manufacturer.

14. Quality control of fiber counts.

a. Prepare and count field blanks along with the field samples. Report the counts on each blank. Calculate the mean of the field blank counts and subtract this value from each sample count before reporting the results.

Note 1.—The identity of the blank filters should be unknown to the counter until all counts have been completed.

Note 2: If a field blank yields fiber counts greater than 7 fibers/100 fields, report possible contamination of the samples.

b. Perform blind recounts by the same counter on 10 percent of filters counted (slides relabeled by a person other than the counter).

15. Use the following test to determine whether a pair of counts on the same filter should be rejected because of possible bias. This statistic estimates the counting repeatability at the 95% confidence level. Discard the sample if the difference between the two counts exceeds $2.77(F)s_r$, where F = average of the two fiber counts and s_r = relative standard deviation, which should be derived by each laboratory based on historical in-house data.

Note.—If a pair of counts is rejected as a result of this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts.

16. Enroll each new counter in a training course that compares performance of counters on a variety of samples using this procedure.

Measurement

17. Place the slide on the mechanical stage of the calibrated microscope with the center of the filter under the objective lens. Focus the microscope on the plane of the filter.

18. Regularly check phase-ring alignment and Kohler illumination.

19. The following are the counting rules:

a. Count only fibers longer than 5 μ m.

Note.—To ensure good reproducibility, all laboratories engaged in asbestos, tremolite, anthophyllite, and actinolite counting are required to participate in the Proficiency Analytical Testing (PAT) Program and should routinely participate with other asbestos, tremolite, anthophyllite, and actinolite fiber counting laboratories in the exchange of field samples to compare performance of counters. Measure the length of curved fibers along the curve.

b. Count only fibers with a length-to-width ratio equal to or greater than 3:1.

c. For fibers that cross the boundary of the graticule field, do the following:

1. Count any fiber longer than 5 μ m that lies entirely within the graticule area.

2. Count as $\frac{1}{2}$ fiber any fiber with only one end lying within the graticule area.

3. Do not count any fiber that crosses the graticule boundary more than once.

4. Reject and do not count all other fibers.

d. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber.

e. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 fields regardless of fiber count.

20. Start counting from one end of the filter and progress along a radial line to the other end, shift either up or down on the filter, and continue in the reverse direction. Select fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. When an agglomerate covers ca. $\frac{1}{4}$ or more of the field of view, reject the field and select another. Do not report rejected fields in the number of total fields counted.

Note.—When counting a field, continuously scan a range of focal planes by moving the fine focus knob to detect very fine fibers which have become embedded in the filter. The small-diameter fibers will be very faint but are an important contribution to the total count.

Calculations

21. Calculate and report fiber density on the filter, E (fibers/mm²); by dividing the total fiber count, F , minus the mean field blank count, B , by the number of fields, n ; and the field area, A_f (0.00785 mm² for a properly calibrated Walton-Beckett graticule):

$$E = \frac{F - B}{(n)(A_f)} \text{ fibers/mm}^2$$

22. Calculate the concentration, C (f/cc), of fibers in the air volume sampled, V (L), using the effective collection area of the filter, A_c (385 mm² for a 25-mm filter):

$$C = \frac{(E)(A_c)}{V(10^3)}$$

Note.—Periodically check and adjust the value of A_c if necessary.

Appendix C to §1926.58—Qualitative and Quantitative Fit Testing Procedures—Mandatory Qualitative Fit Test Protocols

1. Isoamyl Acetate Protocol.

A. Odor Threshold Screening

concentration to be reached before starting the fit-test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in #4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. If the test is failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, and again begin the procedure described in the c(4) through c(8) above. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot pass the fit test described above wearing a half-mask respirator from the available selection, full facepiece models must be used.

12. When a respirator is found that passes the test, the subject breaks the face seal and takes a breath before exiting the chamber. This is to assure that the reason the test subject is not smelling the IAA is the good fit of the respirator facepiece seal and not olfactory fatigue.

13. When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag so there is no significant IAA concentration buildup in the test chamber during subsequent tests.

14. At least two facepieces shall be selected for the IAA test protocol. The test subject shall be given the opportunity to wear them for one week to choose the one which is more comfortable to wear.

15. Persons who have successfully passed this fit test with a half-mask respirator may be assigned the use of the test respirator in atmospheres with up to 10 times the PEL of airborne asbestos. In atmospheres greater than 10 times, and less than 100 times the PEL (up to 100 ppm), the subject must pass the IAA test using a full face negative pressure respirator. (The concentration of the IAA inside the test chamber must be increased by ten times for QLFT of the full facepiece.)

16. The test shall not be conducted if there is any hair growth between the skin the facepiece sealing surface.

17. If hair growth or apparel interfere with a satisfactory fit, then they shall be altered or removed so as to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator such as powered air-purifying respirators, supplied air respirator, or self-contained breathing apparatus.

18. If a test subject exhibits difficulty in breathing during the tests, she or he shall be

referred to a physician trained in respirator diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

19. Qualitative fit testing shall be repeated at least every six months.

20. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

- (1) Weight change of 20 pounds or more,
- (2) Significant facial scarring in the area of the facepiece seal,
- (3) Significant dental changes; i.e., multiple extractions without prosthesis, or acquiring dentures,
- (4) Reconstructive or cosmetic surgery, or
- (5) Any other condition that may interfere with facepiece sealing.

D. Recordkeeping

A summary of all test results shall be maintained in each office for 3 years. The summary shall include:

- (1) Name of test subject,
- (2) Date of testing,
- (3) Name of the test conductor,
- (4) Respirators selected (indicate manufacturer, model, size and approval number),
- (5) Testing agent.

II. Saccharin Solution Aerosol Protocol

A. Respirator Selection

Respirators shall be selected as described in section IB (respirator selection) above, except that each respirator shall be equipped with a particulate filter.

B. Taste Threshold Screening

1. An enclosure about head and shoulders shall be used for threshold screening (to determine if the individual can taste saccharin) and for fit testing. The enclosure shall be approximately 12 inches in diameter by 14 inches tall with at least the front clear to allow free movement of the head when a respirator is worn.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

3. The entire screening and testing procedure shall be explained to the test subject prior to conducting the screening test.

4. During the threshold screening test, the test subject shall don the test enclosure and breathe with open mouth with tongue extended.

5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C 7 below) in 100 cc of water.

7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then is released and allowed to fully expand.

8. Ten squeezes of the nebulizer bulb are

repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

9. If the first response is negative, ten more squeezes of the nebulizer bulb are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.

10. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin can be tasted.

11. The test conductor will take note of the number of squeezes required to elicit a taste response.

12. If the saccharin is not tasted after 30 squeezes (Step 10), the saccharin fit test cannot be performed on the test subject.

13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least every four hours.

C. Fit Test

1. The test subject shall don and adjust the respirator without the assistance from any person.

2. The fit test uses the same enclosure described in IIB above.

3. Each test subject shall wear the respirator for at least 10 minutes before starting the fit test.

4. The test subject shall don the enclosure while wearing the respirator selected in section 1B above. This respirator shall be properly adjusted and equipped with a particulate filter.

5. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

6. A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

7. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

8. As before, the test subject shall breathe with mouth open and tongue extended.

9. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B8 through B10 above).

10. After generation of the aerosol read the following instructions to the test subject. The test subject shall perform the exercises for one minute each.

- i. Breathe normally.
- ii. Breathe deeply. Be certain breaths are deep and regular.
- iii. Turn head all the way from one side to the other. Be certain movement is complete. Inhale on each side. Do not bump the respirator against the shoulders.
- iv. Nod head up-and-down. Be certain

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17. Qualitative fit testing shall be repeated at least every six months.

18. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the test subject has a:

- (1) Weight change of 20 pounds or more,
- (2) Significant facial scarring in the area of the facepiece seal,
- (3) Significant dental changes; i.e.: multiple extractions without prosthesis, or acquiring dentures,
- (4) Reconstructive or cosmetic surgery, or
- (5) Any other condition that may interfere with facepiece sealing.

C. Recordkeeping

A summary of all test results shall be maintained in each office for 3 years. The summary shall include:

- (1) Name of test subject.
- (2) Date of testing.
- (3) Name of test conductor.
- (4) Respirators selected (indicate manufacturer, model, size and approval number).
- (5) Testing agent

Quantitative Fit Test Procedures

1. General.

a. The method applies to the negative-pressure nonpowered air-purifying respirators only.

b. The employer shall assign one individual who shall assume the full responsibility for implementing the respirator quantitative fit test program.

2. Definition.

a. "Quantitative Fit Test" means the measurement of the effectiveness of a respirator seal in excluding the ambient atmosphere. The test is performed by dividing the measured concentration of challenge agent in a test chamber by the measured concentration of the challenge agent inside the respirator facepiece when the normal air purifying element has been replaced by an essentially perfect purifying element.

b. "Challenge Agent" means the air contaminant introduced into a test chamber so that its concentration inside and outside the respirator may be compared.

c. "Test Subject" means the person wearing the respirator for quantitative fit testing.

d. "Normal Standing Position" means standing erect and straight with arms down along the sides and looking straight ahead.

e. "Fit Factor" means the ratio of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. Apparatus.

a. *Instrumentation.* Corn oil, sodium chloride or other appropriate aerosol generation, dilution, and measurement systems shall be used for quantitative fit test.

b. *Test chamber.* The test chamber shall be large enough to permit all test subjects to freely perform all required exercises without distributing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively

isolated from the ambient air yet uniform in concentration throughout the chamber.

c. When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

d. The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000.

e. The combination of substitute air-purifying elements (if any), challenge agent, and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of PEL to the challenge agent at any time during the testing process.

f. The sampling port on the test specimen respirator shall be placed and constructed so that there is no detectable leak around the port, a free air flow, is allowed into the sampling line at all times and so there is no interference with the fit or performance of the respirator.

g. The test chamber and test set-up shall permit the person administering the test to observe one test subject inside the chamber during the test.

h. The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent constant within a 10 percent variation for the duration of the test.

i. The time lag (interval between an event and its being recorded on the strip chart) of the instrumentation may not exceed 2 seconds.

j. The tubing for the test chamber atmosphere and for the respirator sampling port shall be the same diameter, length and material. It shall be kept as short as possible. The smallest diameter tubing recommended by the manufacturer shall be used.

k. The exhaust flow from the test chamber shall pass through a high-efficiency filter before release to the room.

l. When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

4. Procedural Requirements.

a. The fitting of half-mask respirators should be started with those having multiple sizes and a variety of interchangeable cartridges and canisters such as the MSA Comfo II-M, Norton M, Survivair M, A-O M, or Scott-M. Use either of the tests outlined below to assure that the facepiece is properly adjusted.

(1) *Positive pressure test.* With the exhaust port(s) blocked, the negative pressure of slight inhalation should remain constant for several seconds.

(2) *Negative pressure test.* With the intake port(s) blocked, the negative pressure slight inhalation should remain constant for several seconds.

b. After a facepiece is adjusted, the test subject shall wear the facepiece for at least 5 minutes before conducting a qualitative test by using either of the methods described below and using the exercise regime described in 5.a., b., c., d. and e.

(1) *Isoamyl acetate test.* When using organic vapor cartridges, the test subject who

can smell the odor should be unable to detect the odor of isoamyl acetate squirted into the air near the most vulnerable portions of the facepiece seal. In a location which is separated from the test area, the test subject shall be instructed to close her/his eyes during the test period. A combination cartridge or canister with organic vapor and high-efficiency filters shall be used when available for the particular mask being tested. The test subject shall be given an opportunity to smell the odor of isoamyl acetate before the test is conducted.

(2) *Irritant fume test.* When using high-efficiency filters, the test subject should be unable to detect the odor of irritant fume (stannic chloride or titanium tetrachloride ventilation smoke tubes) squirted into the air near the most vulnerable portions of the facepiece seal. The test subject shall be instructed to close her/his eyes during the test period.

c. The test subject may enter the quantitative testing chamber only if she or he has obtained a satisfactory fit as stated in 4.b. of this Appendix.

d. Before the subject enters the test chamber, a reasonably stable challenge agent concentration shall be measured in the test chamber.

e. Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half-mask and 1 percent for a full facepiece.

f. A stable challenge agent concentration shall be obtained prior to the actual start of testing.

(1) *Respirator restraining straps* may not be overtightened for testing. The straps shall be adjusted by the wearer to give a reasonably comfortable fit typical of normal use.

5. *Exercise Regime.* Prior to entering the test chamber, the test subject shall be given complete instructions as to her/his part in the test procedures. The test subject shall perform the following exercises, in the order given, for each independent test.

a. *Normal Breathing (NB).* In the normal standing position, without talking, the subject shall breathe normally for at least one minute.

b. *Deep Breathing (DB).* In the normal standing position the subject shall do deep breathing for at least one minute pausing so as not to hyperventilate.

c. *Turning head side to side (SS).* Standing in place the subject shall slowly turn his/her head from side between the extreme positions to each side. The head shall be held at each extreme position for at least 5 seconds. Perform for at least three complete cycles.

d. *Moving head up and down (UD).* Standing in place, the subject shall slowly move his/her head up and down between the extreme position straight up and the extreme position straight down. The head shall be held at each extreme position for at least 5 seconds. Perform for at least three complete cycles.

e. *Reading (R).* The subject shall read out

Part 1
INITIAL MEDICAL QUESTIONNAIRE

1. NAME _____
2. SOCIAL SECURITY # _____
3. CLOCK NUMBER _____
4. PRESENT OCCUPATION _____
5. PLANT _____
6. ADDRESS _____
7. _____ (Zip Code) _____

8. TELEPHONE NUMBER _____
9. INTERVIEWER _____
10. DATE _____

11. Date of Birth _____
Month _____ Day _____ Year _____
12. Place of Birth _____

13. Sex _____
1. Male _____
2. Female _____
14. What is your marital status? _____
1. Single _____ 4. Separated/Divorced _____
2. Married _____
3. Widowed _____

15. Race _____
1. White _____ 4. Hispanic _____
2. Black _____ 5. Indian _____
3. Asian _____ 6. Other _____

16. What is the highest grade completed in school? _____
(For example 12 years is completion of high school)

OCCUPATIONAL HISTORY

17A. Have you ever worked full time (30 hours per week or more) for 6 months or more? _____
1. Yes _____ 2. No _____
IF YES TO 17A.
B. Have you ever worked for a year or more in any dusty job? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

Specify job/industry _____ Total Years Worked _____
Was dust exposure: 1. Mild _____ 2. Moderate _____ 3. Severe _____
C. Have you ever been exposed to gas or chemical fumes in your work? _____
1. Yes _____ 2. No _____
Specify job/industry _____ Total Years Worked _____
Was exposure: 1. Mild _____ 2. Moderate _____ 3. Severe _____

D. What has been your usual occupation or job--the one you have worked at the longest?
1. Job occupation _____
2. Number of years employed in this occupation _____
3. Position/job title _____
4. Business, field or industry _____

(Record on lines the years in which you have worked in any of these industries, e.g. 1960-1969)

Have you ever worked: YES NO
E. In a mine? _____
F. In a quarry? _____
G. In a foundry? _____
H. In a pottery? _____
I. In a cotton, flax or hemp mill? _____
J. With asbestos? _____

PAST MEDICAL HISTORY

A. Do you consider yourself to be in good health? _____
If "NO" state reason _____
B. Have you any defect of vision? _____
If "YES" state nature of defect _____
C. Have you any hearing defect? _____
If "YES" state nature of defect _____

D. Are you suffering from or have you ever suffered from:

a. Epilepsy (or fits, seizures, convulsions)? _____
b. Rheumatic fever? _____
c. Kidney disease? _____
d. Bladder disease? _____
e. Diabetes? _____
f. Jaundice? _____

19. CHEST COLD AND CHEST ILLNESSES

19A. If you get a cold, does it usually go to your chest? (Usually means more than 1/2 the time) _____
1. Yes _____ 2. No _____
3. Don't get colds _____

20A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? _____
1. Yes _____ 2. No _____

IF YES TO 20A:

B. Did you produce phlegm with any of these chest illnesses? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. In the last 3 years, how many such illnesses with (increased) phlegm did you have which lasted a week or more? _____
Number of illnesses: _____
No such illnesses: _____

21. Did you have any lung trouble before the age of 16? _____
1. Yes _____ 2. No _____

22. Have you ever had any of the following?

1A. Attacks of bronchitis? _____
1. Yes _____ 2. No _____

IF YES TO 1A:

B. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. At what age was your first attack? _____
Age in Years: _____
Does Not Apply: _____

2A. Pneumonia (include bronchopneumonia)? _____
1. Yes _____ 2. No _____

IF YES TO 2A:

B. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. At what age did you first have it? _____
Age in Years: _____
Does Not Apply: _____

1A. Hay Fever?

1. Yes _____ 2. No _____

IF YES TO 1A:

B. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. At what age did it start? _____
Age in Years: _____
Does Not Apply: _____

23A. Have you ever had chronic bronchitis?

1. Yes _____ 2. No _____

IF YES TO 23A:

B. Do you still have it? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

D. At what age did it start? _____
Age in Years: _____
Does Not Apply: _____

24A. Have you ever had emphysema?

1. Yes _____ 2. No _____

IF YES TO 24A:

B. Do you still have it? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

D. At what age did it start? _____
Age in Years: _____
Does Not Apply: _____

25A. Have you ever had asthma?

1. Yes _____ 2. No _____

IF YES TO 25A:

B. Do you still have it? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

C. Was it confirmed by a doctor? _____
1. Yes _____ 2. No _____
3. Does Not Apply _____

D. At what age did it start? _____
Age in Years: _____
Does Not Apply: _____

E. If you no longer have it, at what age did it stop? _____
Age stopped: _____
Does Not Apply: _____

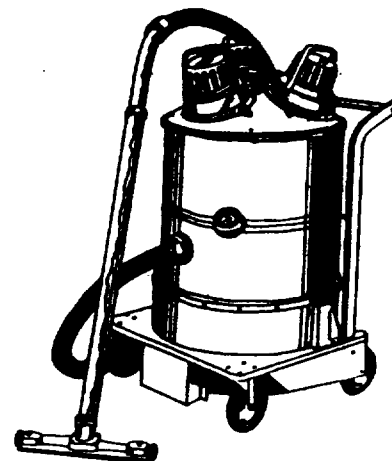
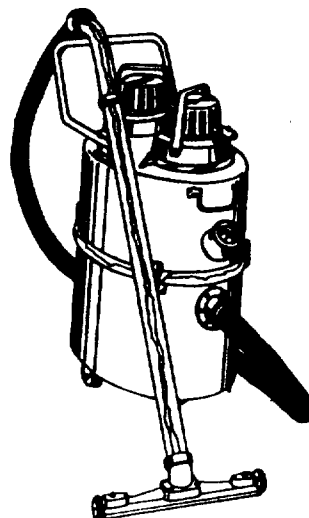
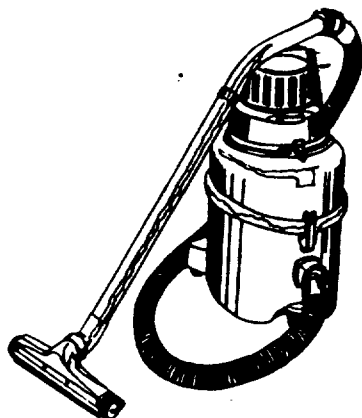
26. Have you ever had:

A. Any other chest illness? _____
1. Yes _____ 2. No _____

If yes, please specify _____

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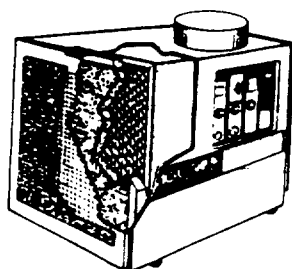


Source: Product Catalog, Asbestos Control Technologies, Inc., Maple Shade, N.J., 1985.

Figure F-1. HEPA Filtered Vacuums

of reaching out-of-the-way places, such as areas above ceiling tiles, behind pipes, etc.

Exhaust Air Filtration System. A portable ventilation system is necessary to create a negative pressure within the asbestos removal enclosure. Such units are equipped with a HEPA filter and are designed to exhaust and clean the air inside the enclosure before exhausting it to the outside of the enclosure (See Figure F-2). Systems are available from several manufacturers. One supplier, Micro-Trap, Inc.,* has two ventilation units that range in capacity from 600 cubic feet per minute (CFM) to 1,700 CFM. According to the manufacturer's literature, Micro-Trap* units filter particles of 0.3 micron in size with an efficiency of 99.99 percent. The number and capacity of units required to ventilate an enclosure depend on the size of the area to be ventilated.



Source: Product Catalog, Asbestos Control Technologies, Inc., Maple Shade, N.J., 1985.

Figure F-2. Portable Exhaust Ventilation System with HEPA Filter

Wetting Agents. Wetting agents (surfactants) are added to water (which is then called amended water) and used to soak asbestos-containing materials; amended water penetrates more effectively than plain water and permits more thorough soaking of the asbestos-containing materials. Wetting

the asbestos-containing material reduces the number of fibers that will break free and become airborne when the asbestos-containing material is handled or otherwise disturbed. Asbestos-containing materials should be thoroughly soaked before removal is attempted; the dislodged material should feel spongy to the touch. Wetting agents are generally prepared by mixing 1 to 3 ounces of wetting agent to 5 gallons of water.

One type of asbestos, amosite, is relatively resistant to soaking, either with plain or amended water. The work practices of choice when working with amosite containing material are to soak the material as much as possible and then to bag it for disposal immediately after removal, so that the material has no time to dry and be ground into smaller particles that are more likely to liberate airborne asbestos.

In a very limited number of situations, it may not be possible to wet the asbestos-containing material before removing it. Examples of such rare situations are: (1) Removal of asbestos material from a "live" electrical box that was oversprayed with the material when the rest of the area was sprayed with asbestos-containing coating; and (2) removing asbestos-containing insulation from a live steam pipe. In both of these situations, the preferred approach would be to turn off the electricity or steam, respectively, to permit wet removal methods to be used. However, where removal work must be performed during working hours, i.e., when normal operations cannot be disrupted, the asbestos-containing material must be removed dry. Immediate bagging is then the only method of minimizing the amount of airborne asbestos generated.

Airless Sprayer. Airless sprayers are used to apply amended water to asbestos-containing materials. Airless sprayers allow the amended water to be applied in a fine spray that minimizes the release of asbestos fibers by reducing the impact of the spray on the material to be removed. Airless sprayers

are inexpensive and readily available.

Portable Shower. Unless the site has available a permanent shower facility that is contiguous to the removal area, a portable shower system is necessary to permit employees to clean themselves after exposure to asbestos and to remove any asbestos contamination from their hair and bodies. Taking a shower prevents employees from leaving the work area with asbestos on their clothes and thus prevents the spread of asbestos contamination to areas outside the asbestos removal area. This measure also protects members of the families of asbestos workers from possible exposure to asbestos. Showers should be supplied with warm water and a drain. A shower water filtration system to filter asbestos fibers from the shower water is recommended. Portable shower units are readily available, inexpensive, and easy to install and transport.

Respirators. Employees involved in asbestos removal projects should be provided with appropriate NIOSH-approved respirators. Selection of the appropriate respirator should be based on the concentration of asbestos fibers in the work area. If the concentration of asbestos fibers is unknown, employees should be provided with respirators that will provide protection against the highest concentration of asbestos fibers that can reasonably be expected to exist in the work area. For most work within an enclosure, employees should wear half-mask dual-filter cartridge respirators. Disposable face mask respirators (single-use) should not be used to protect employers from exposure to asbestos fibers.

Disposable Coveralls. Employees involved in asbestos removal operations should be provided with disposable impervious coveralls that are equipped with head and foot covers. Such coveralls are typically made of Tyvek.¹ The coverall has a zipper

¹ Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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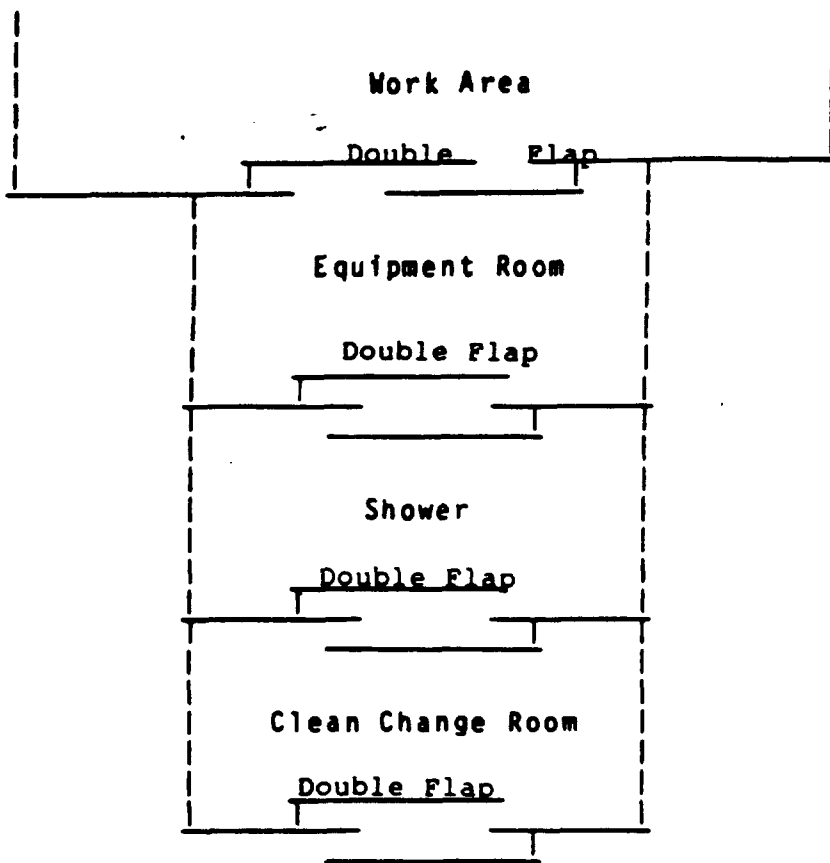


Figure F-4. Typical Hygiene Facility Layout

renovation enclosure. The shower must be drained properly after each use to ensure that contaminated water is not released to uncontaminated areas. If waste water is inadvertently released, it should be cleaned up as soon as possible to prevent any asbestos in the water from drying and becoming airborne in areas outside the work area.

Establishing Negative Pressure Within the Enclosure

After construction of the enclosure is completed, a ventilation system(s) should be installed to create a negative pressure within the enclosure with respect to the area outside the enclosure. Such ventilation systems must be equipped with HEPA filters to prevent the release of asbestos fibers to the environment outside the enclosure and should be operated 24 hours per day during the entire project until the final cleanup is completed and the results of final air samples are received from the laboratory. A sufficient amount of air should be exhausted to create a pressure of -0.02 inches of water within the enclosure with respect to the area outside the enclosure.

These ventilation systems should exhaust the HEPA-filtered clean air outside the building in which the asbestos removal, demolition, or renovation is taking place (see

Figure F-5). If access to the outside is not available, the ventilation system can exhaust the HEPA-filtered asbestos-free air to an area within the building that is as far away as possible from the enclosure. Care should be taken to ensure that the clean air is released either to an asbestos-free area or in such a way as not to disturb any asbestos-containing materials.

A manometer or pressure gauge for measuring the negative pressure within the enclosure should be installed and should be monitored frequently throughout all work shifts during which asbestos removal, demolition, or renovation takes place. Several types of manometers and pressure gauges are available for this purpose.

All asbestos removal, renovation, and demolition operations should have a program for monitoring the concentration of airborne asbestos and employee exposures to asbestos. Area samples should be collected inside the enclosure (approximately four samples for 5000 square feet of enclosure area). At least two samples should be collected outside the work area, one at the entrance to the clean change room and one at the exhaust of the portable ventilation system. In addition, several breathing zone samples should be collected from those workers who can reasonably be expected to have the highest potential exposure to

asbestos.

Removing Asbestos Materials

Paragraph (e)(6)(ii) requires that employers involved in asbestos removal, demolition, or renovation operations designate a competent person to:

- (1) Set up the enclosure;
- (2) Ensure the integrity of the enclosure;
- (3) Control entry to and exit from the enclosure;
- (4) Supervise all employee exposure monitoring required by this section;
- (5) Ensure the use of protective clothing and equipment;
- (6) Ensure that employees are trained in the use of engineering controls, work practices, and personal protective equipment;
- (7) Ensure the use of hygiene facilities and the observance of proper decontamination procedures; and
- (8) Ensure that engineering controls are functioning properly.

The competent person will generally be a Certified Industrial Hygienist, an industrial hygienist with training and experience in the handling of asbestos, or a person who has such training and experience as a result of on-the-job training and experience.

Ensuring the integrity of the enclosure is accomplished by inspecting the enclosure before asbestos removal work begins and prior to each work shift throughout the entire period work is being conducted in the enclosure. The inspection should be conducted by locating all areas where air might escape from the enclosure; this is best accomplished by running a hand over all seams in the plastic enclosure to ensure that no seams are ripped and the tape is securely in place.

The competent person should also ensure that all unauthorized personnel do not enter the enclosure and that all employees and other personnel who enter the enclosure have the proper protective clothing and equipment. He or she should also ensure that all employees and other personnel who enter the enclosure use the hygiene facilities and observe the proper decontamination procedures (described below).

Proper work practices are necessary during asbestos removal, demolition, and renovation to ensure that the concentration of asbestos fibers inside the enclosure remains as low as possible. One of the most important work practices is to wet the asbestos-containing material before it is disturbed. After the asbestos-containing material is thoroughly wetted, it should be removed by scraping (as in the case of sprayed-on or troweled-on ceiling material) or removed by cutting the metal bands or wire mesh that support the asbestos-containing material on boilers or pipes. Any residue that remains on the surface of the object from which asbestos is being removed should be wire brushed and wet wiped.

Bagging asbestos waste material promptly after its removal is another work practice control that is effective in reducing the airborne concentration of asbestos within the

ST0085644

Asbestos Removal, Renovation, and Demolition Checklist

Date: _____ Location: _____
 Supervisor _____ Project # _____
 Work Area (sq. ft.) _____

	Yes	No
I. Work site barrier		
Floor covered	_____	_____
Walls covered	_____	_____
Area ventilation off	_____	_____
All edges sealed	_____	_____
Penetrations sealed	_____	_____
Entry curtains	_____	_____
II. Negative Air Pressure		
HEPA Vac _____ Ventilation system _____		
Constant operation	_____	_____
Negative pressure achieved	_____	_____
III. Signs		
Work area entrance	_____	_____
Bags labeled	_____	_____
IV. Work Practices		
Removed material promptly bagged	_____	_____
Material worked wet	_____	_____
HEPA vacuum used	_____	_____
No smoking	_____	_____
No eating, drinking	_____	_____
Work area cleaned after completion	_____	_____
Personnel decontaminated each departure	_____	_____
V. Protective Equipment		
Disposable clothing used one time	_____	_____
Proper NIOSH-approved respirators	_____	_____
VII. Showers		
On site	_____	_____
Functioning	_____	_____
Soap and towels	_____	_____
Used by all personnel	_____	_____

ST0085646

Figure F-6. Checklist

and the construction of mini-enclosures. The procedures that employers must use for each of these operations if they wish to avail themselves of the final rule's exemptions are described in the following sections.

Glove Bags

As discussed in the Summary and Explanation section of the preamble for paragraph (g), Methods of Compliance, evidence in the record indicate that the use of glove bags to enclose the work area during small-scale, short-duration maintenance or renovation activities will result in employee exposures to asbestos that are below the final standard's action level of 0.1 f/cc. This appendix provides requirements for glove-bag procedures to be followed by employers wishing to avail themselves of the standard's exemptions for each activities. OSHA has determined that the use of these procedures will reduce the 8 hour time weighted average (TWA) exposures of employees involved in these work operations to levels below the action level and will thus provide a degree of employee protection equivalent to that provided by compliance with all provisions of the final rule.

Glove Bag Installation. Glove bags are approximately 40-inch-wide times 64-inch-long bags fitted with arms through which the work can be performed (see Figure G-1(A)). When properly installed and used, they permit workers to remain completely isolated from the asbestos material removed or replaced inside the bag. Glove bags can thus provide a flexible, easily installed, and quickly dismantled temporary small work area enclosure that is ideal for small-scale asbestos renovation or maintenance jobs.

These bags are single use control devices that are disposed of at the end of each job. The bags are made of transparent 6-mil-thick polyethylene plastic with arms of Tyvek^{*} material (the same material used to make the disposable protective suits used in major asbestos removal, renovation, and demolition operations and in protective gloves). Glove bags are readily available from safety supply stores or specialty asbestos removal supply houses. Glove bags come pre-labeled with the asbestos warning label prescribed by OSHA and EPA for bags used to dispose of asbestos waste.

Glove Bag Equipment and Supplies. Supplies and materials that are necessary to use glove bags effectively include:

- (1) Tape to seal the glove bag to the area from which asbestos is to be removed;
- (2) Amended water or other wetting agents;
- (3) An airless sprayer for the application of the wetting agent;

^{*} Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

- (4) Bridging encapsulant (a paste-like substance for coating asbestos) to seal the rough edges of any asbestos-containing materials that remain within the glove bag at the points of attachment after the rest of the asbestos has been removed;

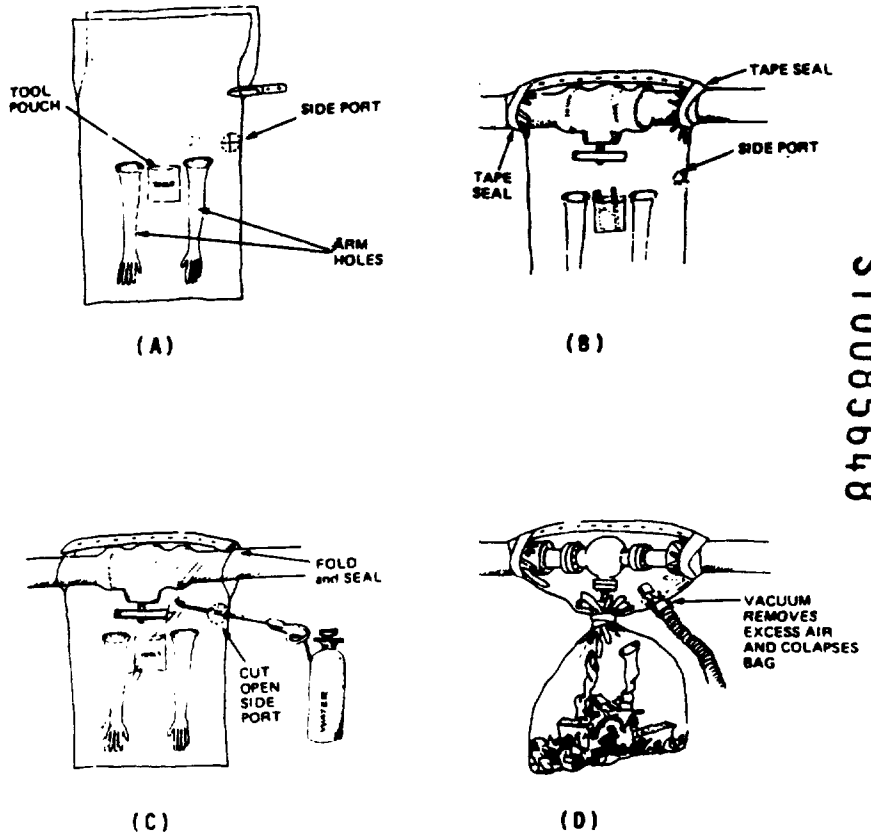


Figure G-1. Diagrams Showing Proper Use of Glove Bags in Small-Scale, Short-Duration Maintenance and Renovation Operations.

- (5) Tools such as razor knives, nips, and wire brushes (or other tools suitable for cutting wire, etc.);

- (6) A HEPA filter-equipped vacuum for evacuating the glove bag (to minimize the release of asbestos fibers) during removal of the bag from the work area and for cleaning any material that may have escaped during the installation of the glove bag; and

- (7) HEPA-equipped dust cartridge respirators for use by the employees involved in the removal of asbestos with the glove bag.

Glove Bag Work Practices. The proper use of glove bags requires the following steps:

- (1) Glove bags must be installed so that they completely cover the pipe or other structure where asbestos work is to be done. Glove bags are installed by cutting the sides of the glove bag to fit the size of the pipe from which asbestos is to be removed. The glove bag is attached to the pipe by folding the open edges together and securely sealing them with tape. All openings in the glove bag must be sealed with duct tape or equivalent material. The bottom seam of the glove bag must also be sealed with duct tape or equivalent to prevent any leakage from the bag that may result from a defect in the bottom seam (Figure G-1(B)).

- (2) The employee who is performing the asbestos removal with the glove bag must don a half mask dual-cartridge HEPA-equipped respirator: respirators should be worn by employees who are in close contact with the glove bag and who may thus be exposed as a result of small gaps in the seams of the bag or holes punched through the bag by a razor knife or a piece of wire mesh.

- (3) The removed asbestos material from the pipe or other surface that has fallen into the enclosed bag must be thoroughly wetted with a wetting agent (applied with an airless sprayer through the pre-cut port provided in most glove bags or applied through a small hole cut in the bag) (Figure G-1(C)).

- (4) Once the asbestos material has been thoroughly wetted, it can be removed from the pipe, beam or other surface. The choice of tool to use to remove the asbestos-containing material depends on the type of material to be removed. Asbestos-containing materials are generally covered with painted canvas and/or wire mesh. Painted canvas can be cut with a razor knife and peeled away from the asbestos-containing material underneath. Once the canvas has been peeled away, the asbestos-containing material underneath may

depends on the building owner's preference, i.e., for removal or containment. Owners consider such factors as cost effectiveness, the physical configuration of the work area, and the amount of traffic in the area when determining which abatement method to use.

If the owner chooses to enclose the structure rather than to remove the asbestos-containing material insulating it, a solid structure (airtight walls and ceilings) must be built around the asbestos covered pipe or structure to prevent the release of asbestos-containing materials into the area beyond the enclosure and to prevent disturbing these materials by casual contact during future maintenance operations.

Such a permanent (i.e., for the life of the building) enclosure should be built of new construction materials and should be impact resistant and airtight. Enclosure walls should be made of tongue-and-groove boards, boards with spine joints, or gypsum boards having taped seams. The underlying structure must be able to support the weight of the enclosure. (Suspended ceilings with laid in panels do not provide airtight enclosures and should not be used to enclose structures covered with asbestos-containing materials.) All joints between the walls and ceiling of the enclosure should be caulked to prevent the escape of asbestos fibers. During the installation of enclosures, tools that are used (such as drills or rivet tools) should be equipped with HEPA-filtered vacuums. Before constructing the enclosure, all electrical conduits, telephone lines, recessed lights, and pipes in the area to be enclosed should be moved to ensure that the enclosure will not have to be re-opened later for routine or emergency maintenance. If such lights or other equipment cannot be moved to a new location for logistic reasons, or if moving them will disturb the asbestos-containing materials, removal rather than enclosure of the asbestos-containing materials is the appropriate control method to use.

Maintenance Program

An asbestos maintenance program must be initiated in all facilities that have asbestos-containing materials. Such a program should include:

- Development of an inventory of all asbestos-containing materials in the facility;
- Periodic examination of all asbestos-containing materials to detect deterioration;
- Written procedures for handling asbestos materials during the performance of small-scale, short-duration maintenance and renovation activities;
- Written procedures for asbestos disposal; and
- Written procedures for dealing with asbestos-related emergencies.

Members of the building's maintenance engineering staff (electricians, heating/air conditioning engineers, plumbers, etc.) who may be required to handle asbestos-containing materials should be trained in safe procedures. Such training should include at a minimum:

- Information regarding types of asbestos and its various uses and forms;
- Information on the health effects associated with asbestos exposure;

- Descriptions of the proper methods of handling asbestos-containing materials; and
- Information on the use of HEPA-equipped dual cartridge respiratory and other personal protection during maintenance activities.

Prohibited Activities

The training program for the maintenance engineering staff should describe methods of handling asbestos-containing materials as well as routine maintenance activities that are prohibited when asbestos-containing materials are involved. For example, maintenance staff employees should be instructed:

- Not to drill holes in asbestos-containing materials;
- Not to hang plants or pictures on structures covered with asbestos-containing materials;
- Not to sand asbestos-containing floor tile;
- Not to damage asbestos-containing materials while moving furniture or other objects;
- Not to install curtains, drapes, or dividers in such a way that they damage asbestos-containing materials;
- Not to dust floors, ceilings, moldings or other surfaces in asbestos-contaminated environments with a dry brush or sweep with a dry broom;
- Not to use an ordinary vacuum to clean up asbestos-containing debris;
- Not to remove ceiling tiles below asbestos-containing materials without wearing the proper respiratory protection, clearing the area of other people, and observing asbestos removal waste disposal procedures;
- Not to remove ventilation system filters dry; and
- Not to shake ventilation system filters.

¹ Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Appendix H to §1926.58—Substance Technical Information for Asbestos—Non-Mandatory

I. Substance Identification

A. Substance: "Asbestos" is the name of a class of magnesium-silicate minerals that occur in fibrous form. Minerals that are included in this group are chrysotile, crocidolite, amosite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos.

B. Asbestos, tremolite, anthophyllite, and actinolite are used in the manufacture of heat-resistant clothing, automotive brake and clutch linings, and a variety of building materials including floor tiles, roofing felts, ceiling tiles, asbestos-cement pipe and sheet, and fire-resistant drywall. Asbestos is also present in pipe and boiler insulation materials, and in sprayed-on materials located on beams, in crawlspaces, and between walls.

C. The potential for a product containing

asbestos, tremolite, anthophyllite, and actinolite to release breathable fibers depends on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to emit fibers. The fibrous or fluffy sprayed-on materials used for fireproofing, insulation, or sound proofing are considered to be friable, and they readily release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tile or roofing felts are considered nonfriable and generally do not emit airborne fibers unless subjected to sanding or sawing operations. Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken during demolition operations.

D. Permissible exposure: Exposure to airborne asbestos, tremolite, anthophyllite, and actinolite fibers may not exceed 0.2 fibers per cubic centimeter of air (0.2 f/cc) averaged over the 8-hour workday.

II. Health Hazard Data

A. Asbestos, tremolite, anthophyllite, and actinolite can cause disabling respiratory disease and various types of cancers if the fibers are inhaled. Inhaling or ingesting fibers from contaminated clothing or skin can also result in these diseases. The symptoms of these diseases generally do not appear for 20 or more years after initial exposure.

B. Exposure to asbestos, tremolite, anthophyllite, and actinolite has been shown to cause lung cancer, mesothelioma, and cancer of the stomach and colon. Mesothelioma is a rare cancer of the thin membrane lining of the chest and abdomen. Symptoms of mesothelioma include shortness of breath, pain in the walls of the chest, and/or abdominal pain.

III. Respirators and Protective Clothing

A. Respirators: You are required to wear a respirator when performing tasks that result in asbestos, tremolite, anthophyllite, and actinolite exposure that exceeds the permissible exposure limit (PEL) of 0.2 f/cc. These conditions can occur while your employer is in the process of installing engineering controls to reduce asbestos, tremolite, anthophyllite, and actinolite exposure, or where engineering controls are not feasible to reduce asbestos, tremolite, anthophyllite, and actinolite exposure. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos, tremolite, anthophyllite, and actinolite fiber concentrations do not exceed 2 f/cc; otherwise, air-supplied, positive-pressure, full facepiece respirators must be used. Disposable respirators or dust masks are not permitted to be used for asbestos, tremolite, anthophyllite, and actinolite work. For effective protection, respirators must fit your face and head snugly. Your employer is required to conduct fit tests when you are first assigned a respirator and every 6 months thereafter. Respirators should not be loosened or removed in work situations where their use is required.

B. Protective Clothing: You are required to

by the employer to eliminate or mitigate further exposure should also lower the risk of serious long-term consequences.

The employer is required to institute a medical surveillance program for all employees who are or will be exposed to asbestos, tremolite, anthophyllite, and actinolite at or above the action level (0.1 fiber per cubic centimeter of air) for 30 or more days per year and for all employees who are assigned to wear a negative-pressure respirator. All examinations and procedures must be performed by or under the supervision of a licensed physician, at a reasonable time and place, and at no cost to the employee.

Although broad latitude is given to the physician in prescribing specific tests to be included in the medical surveillance program, OSHA requires inclusion of the following elements in the routine examination:

(i) Medical and work histories with special emphasis directed to symptoms of the respiratory system, cardiovascular system, and digestive tract.

(ii) Completion of the respiratory disease questionnaire contained in Appendix D.

(iii) A physical examination including a chest roentgenogram and pulmonary function

test that includes measurement of the employee's forced vital capacity (FVC) and forced expiratory volume at one second (FEV₁).

(iv) Any laboratory or other test that the examining physician deems by sound medical practice to be necessary.

The employer is required to make the prescribed tests available at least annually to those employees covered; more often than specified if recommended by the examining physician; and upon termination of employment.

The employer is required to provide the physician with the following information: A copy of this standard and appendices; a description of the employee's duties as they relate to asbestos exposure; the employee's representative level of exposure to asbestos, tremolite, anthophyllite, and actinolite; a description of any personal protective and respiratory equipment used; and information from previous medical examinations of the affected employee that is not otherwise available to the physician. Making this information available to the physician will aid in the evaluation of the employee's health in relation to assigned duties and fitness to wear personal protective equipment, if required.

The employer is required to obtain a written opinion from the examining physician containing the results of the medical examination; the physician's opinion as to whether the employee has any detected medical conditions that would place the employee at an increased risk of exposure-related disease; any recommended limitations on the employee or on the use of personal protective equipment; and a statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions related to asbestos, tremolite, anthophyllite, and actinolite exposure that require further explanation or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to exposure to asbestos, tremolite, anthophyllite, and actinolite, and a copy of the opinion must be provided to the affected employee.

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