

INTERIM OREGON OCCUPATIONAL SAFETY AND HEALTH CODE

This is an interim codebook section for:

OAR 437, DIVISION 2, GENERAL OCCUPATIONAL SAFETY AND HEALTH RULES (29 CFR 1910)

**SUBDIVISION Z: TOXIC & HAZARDOUS SUBSTANCES:
ASBESTOS (1910.1001)**

(with Related Oregon-Initiated Rules Printed in Italics)



Please place these subdivisions in a looseleaf binder together with other subdivisions of Division 2 as they are adopted. This will serve as your interim copy of Division 2 until the complete volume-format codebook is published.

**OREGON OCCUPATIONAL SAFETY AND HEALTH DIVISION
(OR-OSHA)
DEPARTMENT OF INSURANCE AND FINANCE
SALEM, OREGON 97310**



This agency is now part of the
Oregon Department of
Consumer & Business Services.

AO 11-1992

The Oregon Department of Insurance and Finance adopted these rules pursuant to ORS 654.025(2).

The Secretary of State designated OAR Chapter 437 as the "Oregon Occupational Safety and Health Code." Six general subject areas within this code are designated as "Divisions."

Oregon-initiated rules in this division of the Oregon Occupational Safety and Health Code are numbered in a uniform system developed by the Secretary of State. This system does not number the rules in sequence (001, 002, 003, etc.). Omitted numbers may be assigned to new rules at the time of their adoption.

A list of all occupational safety and health codes for the State of Oregon is available upon request.

To obtain this list or copies of these codes, address:

**Oregon Occupational Safety and Health Division
Department of Insurance and Finance
1st Floor, Labor and Industries Building
Salem, Oregon 97310**

The rules referenced in this division are available for viewing in the Office of the Secretary of State, Rules and Records Section, Room 142, State Capitol Building, Salem, Oregon 97310, or the Central Office; Oregon Occupational Safety and Health Division of the Department of Insurance and Finance, 1st Floor, Labor and Industries Building, Summer and Chemeketa Streets NE, Salem, Oregon 97310.

Oregon-Initiated rules are arranged in the following Basic Codification Structure adopted by the Secretary of State for Oregon Administrative Rules (OAR):

Chapter	Division	Rule	Section	Subsection	Paragraphs
437	40	010	(1)	(a)	(A) (i) (I) (a) (A) (i) (I)

Federal rules adopted by reference from the Code of Federal Regulations (CFR) are arranged in the following basic federal numbering system:

Chapter	Division	Part	Subdivision	Section	Paragraph	Subparagraphs
437	03	1926	D	.58	(a)	(1) (i) (A) (1) (a)

For the purpose of OAR 437, Oregon Occupational Safety and Health Code, the terms "subdivision" and "subpart" are synonymous.

NOTE: OAR 437, Division 2, Subdivision Z, 29 CFR 1910.1001, federal rules on **ASBESTOS**, and 29 CFR 1910.1101, federal rules for **NON-ASBESTIFORM MINERALS**, were adopted by reference by APD Admin. Order 9-1989, filed 7/7/89, **EFFECTIVE 7/7/89**. These federal standards superseded and replaced OAR 437, Division 115, Asbestos.

Oregon-initiated rules pertaining to Asbestos are printed *in italics* in this subdivision.

This copy includes final federal amendments made to 1910.1001, and the repeal of 1910.1101 by federal OSHA, adopted 10/9/92 by OR-OSHA Admin. Order 11-1992. **NOTE:** The main change made by the final federal amendments to 1910.1001 was the **deletion of references to "tremolite, anthophyllite, and actinolite" and "or a combination of these minerals."** This deletion of wording was made in every sentence where the term "asbestos" now appears alone. No vertical taping in the margin was used for this universal deletion.

A vertical line in the margin identifies where changes **other** than mentioned above have occurred since the last printing of these rules.

OAR 437, DIVISION 2

GENERAL OCCUPATIONAL SAFETY AND HEALTH RULES

SUBDIVISION Z - TOXIC AND HAZARDOUS SUBSTANCES

437-02-360 In addition to, and not in lieu of, any other safety and health codes contained in OAR Chapter 437, the Department adopts by reference the following federal rules as printed in the Code of Federal Regulations, 29 CFR 1910, revised as of 7/1/92:

TOXIC AND HAZARDOUS SUBSTANCES

(1) 29 CFR 1910.1000 **Air contaminants**, published 6/27/74, Federal Register, vol. 39, pp. 23540-23543; amended in the following FR publication: 5/28/75, vol. 40, pp. 23072-23073; 5/3/77, vol. 42, p. 22525; 1/17/78, vol. 43, p. 2600; 2/10/78, vol. 43, p. 5963; 3/29/78, vol. 43, p. 13563; 5/4/78, vol. 43, p. 19624; 6/23/78, vol. 43, p. 27394; 6/30/78, vol. 43, p. 28473; 10/3/78, vol. 43, p. 45809; 11/14/78, vol. 43, p. 53007; 12/8/78, vol. 43, pp. 57602-57603; 2/5/79, vol. 44, p. 7141; 6/18/80, vol. 45, pp. 12416-12417; 7/28/80, vol. 45, pp. 50328-50329; 6/19/81, vol. 46, p. 32022; 6/22/84, vol. 49, p. 25796; 1/2/85, vol. 50, p. 64; 12/13/85, vol. 50, p. 51173; 11/17/86, vol. 51, p. 41477; 9/11/87, vol. 52, p. 34562; 12/4/87, vol. 52, p. 46291; 1/19/89, vol. 54, pp. 2920-2983; 7/5/89, vol. 54, no. 127, pp. 28054-28061; 9/5/89, vol. 54, no. 170, pp. 366767-36768; 11/15/89, vol. 54, no. 219, p. 47513; 2/5/90, vol. 55, no. 24, pp. 3724; 5/9/90, vol. 55, no. 90, pp. 19258-19259; 11/8/90, vol. 55, no. 217, pp. 46948-46950; 7/1/92, vol. 57, no. 127, pp. 29204-29206.

(2) 29 CFR 1910.1001 **Asbestos**, published 6/20/86, Federal Register, vol. 51, no. 119, pp. 22612-22790; amended 10/17/86, FR vol. 51, pp. 37002-37007; amended 5/12/87, FR vol. 52, pp. 17754-17755; amended 9/14/88, FR vol. 53, no. 178, pp. 35610-35627; amended 9/23/88, FR vol. 53, no. 185, p. 37080; amended 7/21/89, FR vol. 54, no. 139, p.

30704-30705; amended 12/20/89, FR vol. 54, no. 243, p. 52028; amended 2/5/90, FR vol. 55, no. 24, pp. 3731-3732; amended 12/10/90, FR vol. 55, no. 237, pp. 50685-50687; amended 9/4/91, FR vol. 56, no. 171, pp. 43699-43700; 3/5/92, FR vol. 57, no. 44, p. 7878; 6/8/92, FR vol. 57, no. 110, p. 24330.

(3) Reserved for 29 CFR 1910.1002 Coal tar pitch volatiles, interpretation of term

(4) Reserved for 29 CFR 1910.1003 4-Nitrobiphenyl

(5) Reserved for 29 CFR 1910.1004 alpha-Naphthylamine

(6) Reserved for 29 CFR 1910.1005 4,4'-Methylene Bis (2-chloroaniline)

(7) Reserved for 29 CFR 1910.1006 Methyl chloromethyl ether

(8) Reserved for 29 CFR 1910.1007 3,3'-Dichlorobenzidine (and its salts)

(9) Reserved for 29 CFR 1910.1008 bis-Chloromethyl ether

(10) Reserved for 29 CFR 1910.1009 beta-Naphthylamine

(11) Reserved for 29 CFR 1910.1010 Benzidine

(12) Reserved for 29 CFR 1910.1011 4-Aminodiphenyl

(13) Reserved for 29 CFR 1910.1012 Ethyleneimine

(14) Reserved for 29 CFR 1910.1013 beta-Propiolactone

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(16) Reserved for 29 CFR 1910.1015 4-Dimethylamino-azobenzene

(17) Reserved for 29 CFR 1910.1016 N-Nitrosodime-thylamine

(18) Reserved for 29 CFR 1910.1017 Vinyl chloride

(19) Reserved for 29 CFR 1910.1018 Inorganic arsenic

(20) 29 CFR 1910.1025 **Lead**, published 11/14/78, Federal Register, vol. 44, p. 53007; amended by the following FR publications: 1/26/79, vol. 44, p. 5447; 3/13/79, vol. 44, p. 14554; 8/28/79, vol. 44, p. 50338; 10/23/79, vol. 44, p. 60981; 11/30/79, vol. 44, 68828; 5/23/80, vol. 45, p. 35283; 12/11/81, vol. 46, p. 60775; 11/12/82, vol. 47, p. 51117; 3/6/83, vol. 48, p. 9641; 4/30/84, vol. 49, p. 18295; 6/5/84, vol. 49, p. 23175; 6/5/84, vol. 49, p. 23175; and modified by OSHA Instruction CPL 2-2.47 published by the U. S. Department of Labor on 1/5/89. Amended 7/11/89, vol. 54, p. 29142; 1/30/90, vol. 55, no. 20, pp. 3166-3167; 2/13/90, vol. 55, no. 30, pp. 4998-4999; modification of OSHA Instruction CPL 2-2.47, published by Office of Health Compliance Assistance, OSHA, on 7/10/90. Amended 5/31/91, FR vol. 56, no. 105, p. 24686.

(21) 29 CFR 1910.1027 **Cadmium**, published 9/14/92, Federal Register, vol. 57, no. 178, pp. 42388-42453.

(22) 29 CFR 1910.1028 **Benzene**, and Appendices A, B, C, D, and E; published 9/11/87, Federal Register, vol. 52, no. 176, pp. 34562-34578.

(23) Reserved for 29 CFR 1910.1029 Coke oven emissions

(24) 29 CFR 1910.1030 **Bloodborne pathogens**, published 12/6/91, Federal Register, vol. 56, no. 235, pp. 64175-64182; amended 7/1/92, vol. 57, no. 127, p. 29206.

(25) Reserved for 29 CFR 1910.1043 Cotton dust

(26) Reserved for 29 CFR 1910.1044 1,2-dibromo-3-chloropropane

(27) Reserved for 29 CFR 1910.1045 Acrylonitrile

(28) 29 CFR 1910.1047 **Ethylene oxide**, published 6/22/84, Federal Register, vol. 49, p. 25796; amended 3/12/85, FR vol. 50, p. 9801; amended 10/11/85, FR vol. 50, p. 41494; amended 7/10/86, FR vol. 51, p. 25053; amended 4/6/88, FR vol. 53, p. 11437; amended 7/26/88, FR vol. 53, p. 27960.

(29) 29 CFR 1910.1048 **Formaldehyde**, and Appendices A, B, C, D and E, published 12/4/87, Federal Register, vol. 52, no. 233, pp. 46291-46312; and amendments to 1910.1048 published 3/2/88, FR vol. 53, no. 41, pp. 6628-6629; 11/8/88, FR vol.

53, pp. 45080-45088; 11/22/88, FR vol. 53, p. 47188; 7/13/89, FR vol. 54, no. 133, pp. 29545-29546; 8/1/89, FR Vol. 54, No. 146, p. 31765; 8/29/89, FR vol. 54, p. 35639; 9/11/89, FR vol. 54, p. 37531; 10/24/89, vol. 54, pp. 43344-43346; 6/13/90, FR vol. 55, no. 114, p. 24070; 8/10/90, FR vol. 55, no. 155, p. 32616; 12/17/90, FR vol. 55, no. 242, p. 51698; 3/12/91, FR vol. 56, no. 48, pp. 10377-8; 6/12/91, FR vol. 56, no. 113, p. 26909; 8/8/91, FR vol. 56, no. 153, p. 37650-1, 11/13/91, FR vol. 56, no. 219, p. 57593; 1/23/92, FR vol. 57, no. 15, p. 2681-2; 5/5/92, FR vol. 57, no. 87, p. 19262; 5/27/92, FR vol. 57, no. 102, pp. 22307-9; 6/10/92, FR vol. 57, no. 112, p. 24701; 6/18/92, FR vol. 57, no. 118, pp. 27160-1.

(NOTE: 29 CFR 1910.1101 **Asbestos**, was repealed by FR vol. 57, no. 110, issued 6/8/92, p. 24330.)

(30) Reserved for 29 CFR 1910.1200 Hazard communication

(31) 29 CFR 1910.1450 **Occupational Exposure to Hazardous Chemicals in Laboratories**, published 1/31/90, Federal Register, vol. 55 no. 21, pp. 3300-3335; corrected 3/6/90, FR vol. 55, no. 44, p. 7967; 7/1/92, vol. 57, no. 127, p. 29204.

(32) Reserved for 29 CFR 1910.1499 Source of Standards.

(33) Reserved for 29 CFR 1910.1500 Standards Organizations.

(34) 29 CFR 1910.1050 **Methylenedianiline (MDA)**, published 8/10/92, Federal Register, vol. 57, no. 154, pp. 35666-35681.

These standards are available at the Oregon Occupational Safety and Health Division, Oregon Department of Insurance and Finance, and the United States Government Printing Office.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 13-1988, f. 8/2/88, ef. 8/2/88 (Benzene).
APD Admin. Order 14-1988, f. 9/12/88, ef. 9/12/88 (Formaldehyde).
APD Admin. Order 18-1988, f. 11/17/88, ef. 11/17/88 (Ethylene Oxide).
APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-Temp).
APD Admin. Order 6-1989, f. 4/20/89, ef. 5/1/89 (Non-Asbestiforms-Temp).
APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos & Non-Asbestiforms-Perm).
APD Admin. Order 11-1989, f. 7/14/89, ef. 8/14/89 (Lead).
APD Admin. Order 13-1989, f. 7/17/89, ef. 7/17/89 (Air Contaminants).
OR-OSHA Admin. Order 1-1990, f. 1/11/90, ef. 1/11/90 (Formaldehyde-Temp).
OR-OSHA Admin. Order 3-1990, f. 1/19/90, ef. 1/19/90 (Asbestos & Non-Asbestiforms-Temp).
OR-OSHA Admin. Order 6-1990, f. 3/2/90, ef. 3/2/90 (Formaldehyde-Perm).

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OR-OSHA Admin. Order 7-1990, f. 3/2/90, ef. 3/2/90 Asbestos & Non-Asbestiforms-Perm).
OR-OSHA Admin. Order 9-1990, f. 5/8/90, ef. 8/8/90 (Labs).
OR-OSHA Admin. Order 11-1990, f. 6/7/90, ef. 7/1/90 (Air Contaminants).
OR-OSHA Admin. Order 13-1990, f. 6/28/90, ef. 8/1/90 (Asbestos-Temp).
OR-OSHA Admin. Order 14-1990, f. 6/28/90, ef. 8/1/90 (Lead).
OR-OSHA Admin. Order 19-1990, f. 8/31/90, ef. 8/31/90 (Asbestos-Perm).
OR-OSHA Admin. Order 20-1990, f. 9/18/90, ef. 9/18/90 (Lead).
OR-OSHA Admin. Order 21-1990, f. 9/18/90, ef. 9/18/90 (Air Contaminants).
OR-OSHA Admin. Order 7-1991, f. 4/25/91, ef. 4/25/91 (Air Contaminants, Asbestos, Formaldehyde).
OR-OSHA Admin. Order 13-1991, f. 10/10/91, ef. 10/10/91 (Lead, Formaldehyde).

OR-OSHA Admin. Order 15-1991, f. 12/13/91, ef. 12/13/91 (Asbestos).
OR-OSHA Admin. Order 1-1992, f. 1/22/92, ef. 1/22/92 (Formaldehyde).
OR-OSHA Admin. Order 4-1992, f. 4/16/92, ef. 4/16/92 (Formaldehyde).
OR-OSHA Admin. Order 5-1992, f. 4/24/92, ef. 7/1/92 (Blood-borne Pathogens).
OR-OSHA Admin. Order 6-1992, f. 5/18/92, ef. 5/18/92 (Asbestos).
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92 (Asbestos).
OR-OSHA Admin. Order 12-1992, f. 10/13/92, ef. 10/13/92 (Formaldehyde).
OR-OSHA Admin. Order 15-1992, f. 12/30/92, ef. 12/30/92 (Air Contaminants, BBP, Labs).
OR-OSHA Admin. Order 1-1993, f. 1/22/93, ef. 1/22/93 (Cadmium, MDA).

§1910.1001 ASBESTOS.

OREGON-INITIATED RULES

437-02-366 Identification of Materials. Prior to starting work, the employer shall make reasonable efforts to determine if materials to be worked on or removed contain asbestos. Reasonable efforts would include, but not be limited to, obtaining manufacturer's information, laboratory analysis of bulk samples, or records indicating the age and composition of materials. A determination shall not be required when an employer assumes that the suspect material contains asbestos and performs the work in accordance with the provisions of 29 CFR 1910.1001.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).
Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).
APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.
OR-OSHA Admin. Order 12-1993, f. 8/20/93, ef. 11/1/93.

437-02-368 Deterioration and Maintenance.

(1) **Deterioration.** Asbestos which has become damaged or deteriorated shall be repaired, enclosed, encapsulated, or removed in accordance with the provisions of 29 CFR 1926.58 in OAR 437, Division 3, Construction.

(2) **Maintenance.** An asbestos maintenance program in accordance with the provisions of 29 CFR 1926.58, Appendix G, in OAR 437, Division 3, Construction, shall be initiated in all facilities that have asbestos-containing materials.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).
Hist: APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89.
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.
OR-OSHA Admin. Order 12-1993, f. 8/20/93, ef. 11/1/93.

1910.1001

(a) Scope and application.

(1) This section applies to all occupational exposures to asbestos in all industries covered by the Occupational Safety and Health Act, except as provided in paragraph (a)(2) of this section.

(2) This section does not apply to construction work as defined in 29 CFR 1910.12(b). (Exposure to asbestos in construction work is covered by 29 CFR 1926.58.)

(b) **Definitions.** "Action level" means an airborne concentration of asbestos 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 have 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.

"Director" means the Director of the 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 that would occur if the employee were not using respiratory protective equipment.

"Fiber" means a particulate form of asbestos 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 0.3 micrometer diameter mono-disperse particles.

"Regulated area" means an area established by the employer to demarcate areas where airborne concentrations of asbestos exceed, or can reasonably be expected to exceed, the permissible exposure limit.

(c) Permissible exposure limits (PELS).

(1) **Time-weighted average limit (TWA).** The employer shall ensure that no employee is exposed to an airborne concentration of asbestos 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.

(2) **Excursion limit.** The employer shall ensure that no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter of air (1 f/cc) as averaged over a sampling period of thirty (30) minutes.

(d) Exposure monitoring.

(1) General.

(i) Determinations of employee exposure shall be made from breathing zone air samples that are representative of the 8-hour TWA and 30-minute short-term exposures of each employee.

(ii) Representative 8-hour TWA employee exposures shall be determined on the basis of one or more samples representing full-shift exposures for each shift for each employee in each job classification in each work area. Representative 30-minute short-term employee exposures shall be determined on the basis of one or more samples representing 30-minute exposures associated with operations that are most likely to produce exposures above the excursion limit for each shift for each job classification in each work area.

(2) Initial monitoring.

(i) Each employer who has a workplace or work operation covered by this standard, except as provided for in paragraphs (d)(2)(ii) and (d)(2)(iii) of this section, shall perform initial monitoring of employees who are, or may reasonably be expected to be exposed to airborne concentrations at or above the action level and/or excursion limit.

(ii) Where the employer has monitored after December 20, 1985, for the TWA and after March 14, 1988, for the excursion limit, and the monitoring satisfies all other requirements of this section, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraph (d)(2)(i) of this section.

(iii) Where the employer has relied upon objective data that demonstrates that asbestos is not capable of being released in airborne concentrations at or above the action level and/or excursion limit under the expected conditions of processing, use, or handling, then no initial monitoring is required.

(3) Monitoring frequency (periodic monitoring) and patterns. After the initial determinations required by paragraph (d)(2)(i) of this section, 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 six months for employees whose exposures may reasonably be foreseen to exceed the action level and/or excursion limit.

(4) Changes in monitoring frequency. If either the initial or the periodic monitoring required by paragraphs (d)(2) and (d)(3) of this section statistically indicates that employee exposures are below the action level and/or excursion limit, the employer may discontinue the monitoring for those employees whose exposures are represented by such monitoring.

(5) Additional monitoring. Notwithstanding the provisions of paragraphs (d)(2)(ii) and (d)(4) of this section, the employer shall institute the exposure monitoring required under paragraphs (d)(2)(i) and (d)(3) of this section whenever there has been a change in the production, process, control equipment, personnel, or work practices that may result in new or additional exposures above the action level and/or excursion limit or when the employer has any reason to suspect that a change may result in new or additional exposures above the action level and/or excursion limit.

(6) Method of monitoring.

(i) All samples taken to satisfy the monitoring requirements of paragraph (d) shall be personal samples collected following the procedures specified in Appendix A.

(ii) All samples taken to satisfy the monitoring requirements of paragraph (d) shall be evaluated using the OSHA Reference Method (ORM) specified in Appendix A of this section, or an equivalent counting method.

(iii) If an equivalent method to the ORM is used, the employer shall ensure that the method meets the following criteria:

(A) Replicate exposure data used to establish equivalency are collected in side-by-side field and laboratory comparisons; and

(B) The comparison indicates that 90% of the samples collected in the range 0.5 to 2.0 times the permissible limit have an accuracy range of plus or minus 25 percent of the ORM results with a 95% confidence level as demonstrated by a statistically valid protocol; and

(C) The equivalent method is documented and the results of the comparison testing are maintained.

(iv) To satisfy the monitoring requirements of paragraph (d) of this section, employers must use the results of monitoring analysis performed by laboratories which have instituted

quality assurance programs that include the elements as prescribed in Appendix A.

(7) Employee notification of monitoring results.

(i) The employer shall, within 15 working days after the receipt of the results of any monitoring performed under the standard, notify the affected employees of these results in writing either individually or by posting of results in an appropriate location that is accessible to affected employees.

(ii) The written notification required by paragraph (d)(7)(i) of this section shall contain the corrective action being taken by the employer to reduce employee exposure to or below the TWA and/or excursion limit, wherever monitoring results indicated that the TWA and/or excursion limit has been exceeded.

(e) Regulated Areas.

(1) **Establishment.** The employer shall establish regulated areas wherever airborne concentrations of asbestos are in excess of the TWA and/or excursion limit prescribed in paragraph (c) of this section.

(2) **Demarcation.** Regulated areas shall be demarcated from the rest of the workplace in any manner that minimizes the number of persons who will be exposed to asbestos.

(3) **Access.** Access to regulated areas shall be limited to authorized persons or to persons authorized by the Act or regulations issued pursuant thereto.

(4) **Provision of respirators.** Each person entering a regulated area shall be supplied with and required to use a respirator, selected in accordance with paragraph (g)(2) of this section.

(5) **Prohibited activities.** The employer shall ensure that employees do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in the regulated areas.

(f) Methods of compliance.

(1) Engineering controls and work practices.

(i) The employer shall institute engineering controls and work practices to reduce and maintain employee exposure to or below the TWA and/or excursion limit, prescribed in paragraph (c) of this section, except to the extent that such controls are not feasible.

(ii) Wherever the feasible engineering controls and work practices that can be instituted are not sufficient to reduce employee exposure to or below the TWA and/or excursion limit

prescribed in paragraph (c) of this section, the employer shall use them to reduce employee exposure to the lowest levels achievable by these controls and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (g) of this section.

(iii) For the following operations, wherever feasible engineering controls and work practices that can be instituted are not sufficient to reduce the employee exposure to or below the TWA and/or excursion limit, prescribed in paragraph (c) of this section, the employer shall use them to reduce employee exposure to or below 0.5 fibers per cubic centimeter of air (as an eight-hour time-weighted average) or 2.5 fibers/cc for 30 minutes (short-term exposure) and shall supplement them by the use of any combination of respiratory protection that complies with the requirements of paragraph (g) of this section, work practices and feasible engineering controls that will reduce employee exposure to or below the TWA and to or below the excursion limit prescribed in paragraph (c) of this section: Coupling cutoff in primary asbestos cement pipe manufacturing; sanding in primary and secondary asbestos cement sheet manufacturing; grinding in primary and secondary friction product manufacturing; carding and spinning in dry textile processes; and grinding and sanding in primary plastic manufacturing.

(iv) **Local exhaust ventilation.** Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with good practices such as those found in the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1979.

(v) **Particular tools.** All hand-operated and power-operated tools which would produce or release fibers of asbestos so as to expose employees to levels in excess of the TWA and/or excursion limit prescribed in paragraph (c) of this section, such as, but not limited to saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems which comply with paragraph (f)(1)(iv) of this section.

(vi) **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 so as to expose employees to levels in excess of the TWA and/or excursion limit, prescribed in paragraph (c) of this section, unless the usefulness of the product would be diminished thereby.

(vii) (Reserved)

(viii) **Particular products and operations.** No asbestos cement, mortar, coating, grouting, 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 fibers of asbestos so as to expose employees to levels in excess of the TWA and/or excursion limit prescribed in paragraph (c) of this section.

(ix) **Compressed air.** Compressed air shall not be used to remove asbestos or materials containing asbestos unless the compressed air is used in conjunction with a ventilation system designed to capture the dust cloud created by the compressed air.

(2) **Compliance program.**

(i) Where the TWA and/or excursion limit is exceeded, the employer shall establish and implement a written program to reduce employee exposure to or below the TWA and to or below the excursion limit by means of engineering and work practice controls as required by paragraph (f)(1) of this section, and by the use of respiratory protection where required or permitted under this section.

(ii) Such programs shall be reviewed and updated as necessary to reflect significant changes in the status of the employer's compliance program.

(iii) Written programs shall be submitted upon request for examination and copying to the Assistant Secretary, the Director, affected employees and designated employee representatives.

(iv) The employer shall not use employee rotation as a means of compliance with the TWA and/or excursion limit.

(g) **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 TWA and/or excursion limit; and

(iv) In emergencies.

(2) **Respirator selection.**

(i) Where respirators are required under this section, the employer shall select and provide, at no cost to the employee, the appropriate respirator as specified in Table 1. The employer shall select respirators from among those jointly approved as being acceptable for protection by the Mine Safety and Health Administration (MSHA) and by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of any negative pressure respirator specified in Table 1 whenever:

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

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

**TABLE 1
RESPIRATORY PROTECTION FOR
ASBESTOS FIBERS**

Airborne concentration of asbestos	Required respirator
Not in excess of 2 f/cc (10 X PEL)	1. Half-mask air-purifying respirator, other than a disposable 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 or larger.

(3) Respirator program.

(i) Where respiratory protection is required, 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 the regulated area 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 upon 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 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 whose duties 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 the employee 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) For each employee wearing negative pressure respirators, employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, and shall be conducted in accordance with Appendix C. The tests shall be used to select facepieces that provide the required protection as prescribed in Table I.

(h) Protective work clothing and equipment.

(1) **Provision and use.** If an employee is exposed to asbestos above the TWA and/or excursion limit, or where the possibility of eye irritation exists, the employer shall provide at no cost to the employee and ensure that the employee uses appropriate work clothing and equipment such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

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(ii) Gloves, head coverings, and foot coverings; and

(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with §1910.133 of this Part.

(2) Removal and storage.

(i) The employer shall ensure that employees remove work clothing contaminated with asbestos only in change rooms provided in accordance with paragraph (i)(1) of this section.

(ii) The employer shall ensure that no employee takes contaminated work clothing out of the change room, except those employees authorized to do so for the purpose of laundering, maintenance, or disposal.

(iii) Contaminated work clothing shall be placed and stored in closed containers which prevent dispersion of the asbestos outside the container.

(iv) Containers of contaminated protective devices or work clothing which are to be taken out of change rooms or the workplace for cleaning, maintenance or disposal, shall bear labels in accordance with paragraph (j)(2) of this section.

(3) Cleaning and replacement.

(i) The employer shall clean, launder, repair, or replace protective clothing and equipment required by this paragraph to maintain their effectiveness. The employer shall provide clean protective clothing and equipment at least weekly to each affected employee.

(ii) The employer shall prohibit the removal of asbestos from protective clothing and equipment by blowing or shaking.

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

(iv) Any employer who gives contaminated clothing to another person for laundering shall inform such person of the requirement of paragraph (h)(3)(iii) of this section to effectively prevent the release of airborne fibers of asbestos in excess of the permissible exposure limit.

(v) The employer shall inform any person who launders or cleans protective clothing or equipment contaminated with asbestos of the potentially harmful effects of exposure to asbestos.

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

(i) Hygiene facilities and practices.

(1) Change rooms.

(i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to asbestos is above the TWA and/or excursion limit.

(ii) The employer shall ensure that change rooms are in accordance with §1910.141(e) of this part, and are equipped with two separate lockers or storage facilities, so separated as to prevent contamination of the employee's street clothes from his protective work clothing and equipment.

(2) Showers.

(i) The employer shall ensure that employees who work in areas where their airborne exposure is above the TWA and/or excursion limit shower at the end of the work shift.

(ii) The employer shall provide shower facilities which comply with §1910.141(d)(3) of this part.

(iii) The employer shall ensure that employees who are required to shower pursuant to paragraph (i)(2)(i) of this section do not leave the workplace wearing any clothing or equipment worn during the work shift.

(3) Lunchrooms.

(i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure is above the TWA and/or excursion limit.

(ii) The employer shall ensure that lunchroom facilities have a positive pressure, filtered air supply, and are readily accessible to employees.

(iii) The employer shall ensure that employees who work in areas where their airborne exposure is above the TWA and/or excursion limit wash their hands and faces prior to eating, drinking, or smoking.

(iv) The employer shall ensure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface asbestos fibers have been removed from the clothing or equipment by vacuuming or other method that removes dust without causing the asbestos to become airborne.

(4) **Smoking in work areas.** The employer shall ensure that employees do not smoke in work areas where they are occupationally exposed to asbestos because of activities in that work area.

(j) Communication of hazards to employees.

(1) Warning signs.

(i) **Posting.** Warning signs shall be provided and displayed at each regulated area. In addition, warning signs shall be posted at all approaches to regulated areas so that an employee may read the signs and take necessary protective steps before entering the area.

(ii) **Sign specifications.** The warning signs required by paragraph (j)(1)(i) of this section shall bear the following information:

**DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA**

(iii) (Reserved)

(iv) The employer shall ensure that employees working in and contiguous to regulated areas comprehend the warning signs required to be posted by paragraph (j)(1)(i) of this section. Means to ensure employee comprehension may include the use of foreign languages, pictographs and graphics.

(2) Warning labels.

(i) **Labeling.** Warning labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers or to their containers.

(ii) **Label specifications.** The labels shall comply with the requirements of 29 CFR 1910.1200(f) of OSHA's Hazard Communication standard, and shall include the following information:

**DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD**

(3) **Material safety data sheets.** Employers who are manufacturers or importers of asbestos or asbestos products shall comply with the requirements regarding development of material safety data sheets as specified in 29 CFR 1910.1200(g) of OSHA's Hazard Communication standard, except as provided by paragraph (j)(4) of this section.

(4) The provisions for labels required by paragraph (j)(2) or for material safety data sheets required by paragraph (j)(3) do not apply where:

(i) Asbestos 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 fibers of asbestos in excess of the action level and/or excursion limit will be released or

(ii) Asbestos is present in a product in concentrations less than 0.1%.

(5) Employee information and training.

(i) The employer shall institute a training program for all employees who are exposed to airborne concentrations of asbestos at or above the action level and/or excursion limit and ensure their participation in the program.

(ii) Training shall be provided prior to or at the time of initial assignment and at least annually thereafter.

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

(A) The health effects associated with asbestos exposure;

(B) The relationship between smoking and exposure to asbestos in producing lung cancer;

(C) The quantity, location, manner of use, release, and storage of asbestos and the specific nature of operations which could result in exposure to asbestos;

(D) The engineering controls and work practices associated with the employee's job assignment;

(E) The specific procedures implemented to protect employees from exposure to asbestos such as appropriate work practices, emergency and clean-up procedures, and personal protective equipment to be used;

(F) The purpose, proper use, and limitations of respirators and protective clothing;

(G) The purpose and a description of the medical surveillance program required by paragraph (l) of this section;

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(H) The content of this standard, including appendices.

(I) The names, addresses and phone numbers of public health organizations which provide information, materials, and/or conduct programs concerning smoking cessation. The employer may distribute the list of such organizations contained in Appendix I, to comply with this requirement.

(J) The requirements for posting signs and affixing labels and the meaning of the required legends for such signs and labels.

(iv) Access to information and training materials.

(A) The employer shall make a copy of this standard and its appendices readily available without cost to all affected employees.

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

(C) The employer shall inform all employees concerning the availability of self-help smoking cessation program material. Upon employee request, the employer shall distribute such material, consisting of NIH Publication No. 89-1647, or equivalent self-help material, which is approved or published by a public health organization listed in Appendix I.

(k) Housekeeping.

(1) All surfaces shall be maintained as free as practicable of accumulations of dusts and waste containing asbestos.

(2) All spills and sudden releases of material containing asbestos shall be cleaned up as soon as possible.

(3) Surfaces contaminated with asbestos may not be cleaned by the use of compressed air.

(4) **Vacuuming.** HEPA-filtered vacuuming equipment shall be used for vacuuming. The equipment shall be used and emptied in a manner which minimizes the reentry of asbestos into the workplace.

(5) Shoveling, dry sweeping and dry clean-up of asbestos may be used only where vacuuming and/or wet cleaning are not feasible.

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

(l) Medical surveillance.

(1) General.

(i) The employer shall institute a medical surveillance program for all employees who are or will be exposed to airborne concentrations of asbestos at or above the action level and/or excursion limit.

(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 shall be provided without cost to the employee and at a reasonable time and place.

(B) Persons other than 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) Preplacement examinations.

(i) Before an employee is assigned to an occupation exposed to airborne concentrations of asbestos fibers, a preplacement medical examination shall be provided or made available by the employer.

(ii) Such examination shall include, as a minimum, a medical and work history; a complete physical examination of all systems with emphasis on the respiratory system, the cardiovascular system and digestive tract; completion of the respiratory disease standardized questionnaire in Appendix D, Part 1; a chest roentgenogram (posterior-anterior 14 x 17 inches); pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV_{1.0}); and any additional tests deemed appropriate by the examining physician. Interpretation and classification of chest roentgenograms shall be conducted in accordance with Appendix E.

(3) Periodic examinations.

(i) Periodic medical examinations shall be made available annually.

(ii) The scope of the medical examination shall be in conformance with the protocol established in paragraph (1)(2)(ii) of this section, except that the frequency of chest roentgenograms shall be conducted in accordance with Table 2, and the abbreviated standardized questionnaire contained in Appendix D, Part 2, shall be administered to the employee.

(iv) A description of any personal protective and respiratory equipment used or to be used.

(v) Information from previous medical examinations of the affected employee that is not otherwise available to the examining physician.

TABLE 2

FREQUENCY OF CHEST ROENTGENOGRAMS

Years since first exposure	Age of employee		
	15 to 35	35+ to 45	45+
0 to 10.....	Every 5 years	Every 5 years	Every 5 years
10+.....	Every 5 years	Every 2 years	Every 1 year

(7) Physician's written opinion.

(i) The employer shall obtain a written signed opinion from the examining physician. This written opinion shall contain the results of the medical examination and shall include:

(A) The physician's opinion as to whether the employee has any detected medical conditions that would place the employee at an increased risk of material health impairment from exposure to asbestos;

(B) Any recommended limitations on the employee or upon the use of personal protective equipment such as clothing or respirators; and

(C) A statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions resulting from asbestos exposure that require further explanation or treatment.

(D) A statement that the employee has been informed by the physician of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos exposure.

(4) Termination of employment examinations.

(i) The employer shall provide, or make available, a termination of employment medical examination for any employee who has been exposed to airborne concentrations of fibers of asbestos at or above the action level and/or excursion limit.

(ii) The medical examination shall be in accordance with the requirements of the periodic examinations stipulated in paragraph (1)(3) of this section, and shall be given within 30 calendar days before or after the date of termination of employment.

(5) Recent examinations. No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with any of the preceding paragraphs (1)(2)-(1)(4) within the past 1 year period.

(6) Information provided to the physician. The employer shall provide the following information to the examining physician:

(i) A copy of this standard and Appendices D and E.

(ii) A description of the affected employee's duties as they relate to the employee's exposure.

(iii) The employee's representative exposure level or anticipated exposure level.

(ii) The employer shall instruct the physician not to reveal in the written opinion given to the employer specific findings or diagnoses unrelated to occupational exposure to asbestos.

(iii) The employer shall provide a copy of the physician's written opinion to the affected employee within 30 days from its receipt.

(m) Recordkeeping.

(1) Exposure measurements.

(i) The employer shall keep an accurate record of all measurements taken to monitor employee exposure to asbestos as prescribed in paragraph (d) of this section.

(ii) This record shall include at least the following information:

(A) The date of measurement;

(B) The operation involving exposure to asbestos which is being monitored;

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(C) Sampling and analytical methods used and evidence of their accuracy;

(D) Number, duration, and results of samples taken;

(E) Type of respiratory protective devices worn, if any; and

(F) Name, social security number and exposure of the employees whose exposure are represented.

(iii) The employer shall maintain this record for at least thirty (30) years, in accordance with 29 CFR 1910.20.

(2) Objective data for exempted operations.

(i) Where the processing, use, or handling of products made from or containing asbestos is exempted from other requirements of this section under paragraph (d)(2)(iii) of this section, the employer shall establish and maintain an accurate record of objective data reasonably relied upon in support of the exemption.

(ii) The record shall include at least the following:

(A) The product qualifying for exemption;

(B) The source of the objective data;

(C) The testing protocol, results of testing, and/or analysis of the material for the release of asbestos;

(D) A description of the operation exempted and how the data support the exemption; and

(E) Other data relevant to the operations, materials, processing, or employee exposures covered by the exemption.

(iii) The employer shall maintain this record for the duration of the employer's reliance upon such objective data.

Note: The employer may utilize the services of competent organizations such as industry trade associations and employee associations to maintain the records required by this section.

(3) Medical surveillance.

(i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance by paragraph (l)(1)(i) of this section, in accordance with 29 CFR 1910.20.

(ii) The record shall include at least the following information:

(A) The name and social security number of the employee;

(B) Physician's written opinions;

(C) Any employee medical complaints related to exposure to asbestos; and

(D) A copy of the information provided to the physician as required by paragraph (l)(6) of this section.

(iii) The employer shall ensure that this record is maintained for the duration of employment plus thirty (30) years, in accordance with 29 CFR 1910.20.

(4) Training. The employer shall maintain all employee training records for one (1) year beyond the last date of employment of that employee.

(5) Availability.

(i) The employer, upon written request, shall make all records required to be maintained by this section available to the Assistant Secretary and the Director for examination and copying.

(ii) The employer, upon request shall make any exposure records required by paragraph (m)(1) of this section available for examination and copying to affected employees, former employees, designated representatives and the Assistant Secretary, in accordance with 29 CFR 1910.20(a)-(e) and (g)-(i).

(iii) The employer, upon request, shall make employee medical records required by paragraph (m)(2) of this section available for examination and copying to the subject employee, to 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 of records and, upon request, transmit them to the Director.

(n) Observation of monitoring.

(1) Employee observation. The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to asbestos conducted in accordance with paragraph (d) of this section.

(2) Observation procedures. When observation of the monitoring of employee exposure to asbestos 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.

(o) Dates.

(1) Effective date. This standard shall become effective July 21, 1986. The requirements of the asbestos standard issued in June 1972 (37 FR 11318), as amended, and published in 29 CFR 1910.1101 remain in effect until compliance is achieved with the parallel provisions of this standard. The requirements in the amended paragraphs in this section which pertain only to or are triggered by the excursion limit shall become effective October 14, 1988.

(2) Start-up dates. All obligations of this standard commence on the effective date except as follows:

(i) Exposure monitoring. Initial monitoring required by paragraph (d)(2) of this section shall be completed as soon as possible but no later than October 20, 1986.

(ii) Regulated areas. Regulated areas required to be established by paragraph (e) of this section as a result of initial monitoring shall be set up as soon as possible after the results of that monitoring are known and not later than November 17, 1986.

(iii) Respiratory protection. Respiratory protection required by paragraph (g) of this section shall be provided as soon as possible but no later than the following schedule:

(A) Employees whose 8-hour TWA exposure exceeds 2 fibers/cc - July 21, 1986.

(B) Employees whose 8-hour TWA exposure exceeds the PEL but is less than 2 fibers/cc - November 17, 1986.

(C) Powered air-purifying respirators provided under paragraph (g)(2)(ii) - January 16, 1987.

(iv) Hygiene and lunchroom facilities. Construction plans for changerooms, showers, lavatories, and lunchroom facilities shall be completed no later than January 16, 1987; and these facilities shall be constructed and in use no later than July 20, 1987. However, if as part of the compliance plan it is predicted by an independent engineering firm that engineering controls and work practices will reduce exposures below the permissible exposure limit by July 20, 1988, for affected employees, then such facilities need not be completed until 1 year after the engineering controls are completed, if such controls have not in fact succeeded in reducing exposure to below the permissible exposure limit.

(v) Employee information and training. Employee information and training required by paragraph (j)(5) of this section shall be provided as soon as possible but no later than October 20, 1986.

(vi) Medical surveillance. Medical examinations required by paragraph (l) of this section shall be provided as soon as possible but no later than November 17, 1986.

(vii) Compliance program. Written compliance programs required by paragraph (f)(2) of this section as a result of initial monitoring shall be completed and available for inspection and copying as soon as possible but no later than July 20, 1987.

(viii) Methods of compliance. The engineering and work practice controls as required by paragraph (f)(1) shall be implemented as soon as possible but no later than July 20, 1988.

(3) Start-up dates for excursion limit. Compliance with the excursion limit requirements in this section shall be as follows:

(i) Paragraphs (c), (d), (e), (g), (h), (j), (k), (l), (m) of this section, shall be complied with by December 13, 1988.

(ii) Paragraph (f) of this section, shall be complied with by March 13, 1989.

(iii) Paragraph (i) of this section, shall be complied with by September 14, 1989.

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(4) Compliance date. The requirements of paragraphs (i)(4), (j)(1)(iv), (j)(5)(iii)(I), (j)(5)(iii)(J), (j)(5)(iv)(C), and (l)(7)(i)(D) shall be complied with by May 7, 1990.

(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 obligation not otherwise imposed or to detract from any existing obligation.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 3-1990, f. 1/19/90, ef. 1/19/90 (temp).

OR-OSHA Admin. Order 7-1990, f. 3/2/90, ef. 3/2/90 (perm).

OR-OSHA Admin. Order 13-1990, f. 6/28/90, ef. 8/1/90 (temp).

OR-OSHA Admin. Order 19-1990, f. 8/31/90, ef. 8/31/90 (perm).

OR-OSHA Admin. Order 7-1991, f. 4/25/91, ef. 4/25/91.

OR-OSHA Admin. Order 15-1991, f. 12/13/91, ef. 12/13/91.

OR-OSHA Admin. Order 6-1992, f. 5/18/92, ef. 5/18/92.

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX A to §1910.1001 - OSHA REFERENCE METHOD - MANDATORY

This mandatory appendix specifies the procedure for analyzing air samples for asbestos 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 (d) 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 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 electrically conductive 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 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 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. In the absence of other information, count all particles as asbestos 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 (1/2). 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 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 laboratory shall submit slides typical of its own work load for use in this program. The round robin shall be designed and results analyzed using appropriate statistical methodology.
3. All individuals performing asbestos analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos dust or an equivalent course.
4. When the use of different microscopes contributes to differences between counters and laboratories, the effect of the different microscope shall be evaluated and the microscope shall be replaced, as necessary.
5. Current results of these quality assurance programs shall be posted in each laboratory to keep the microscopists informed.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-Temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-Perm).

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX B to §1910.1001 - DETAILED PROCEDURE FOR ASBESTOS
SAMPLING AND ANALYSIS - NON-MANDATORY

This appendix contains a detailed procedure for sampling and analysis and includes those critical elements specified in Appendix A. Employers are not required to use this procedure, but they are required to use Appendix A. The purpose of Appendix B is to provide a detailed step-by-step sampling and analysis procedure that conforms to the elements specified in Appendix A. Since this procedure may also standardize the analysis and reduce variability, OSHA encourages employers to use this appendix.

ASBESTOS SAMPLING AND ANALYSIS METHOD

TECHNIQUE: Microscopy, Phase Contrast

ANALYTE: Fibers (manual count)

SAMPLE PREPARATION: Acetone/triacetin method

CALIBRATION: Phase-shift detection limit about
3 degrees

RANGE: 100 to 1300 fibers/mm² filter area

ESTIMATED LIMIT OF DETECTION:
7 fibers/mm² filter area

SAMPLER: Filter (0.8-1.2 um mixed cellulose ester
membrane, 25-mm diameter)

FLOW RATE: 0.5 L/min to 2.5 L/min (25-mm
cassette) 1.0 L/min to 2.5 L/min (37-mm cassette)

SAMPLE VOLUME: Adjust to obtain 100 to 1300
fibers/mm²

SHIPMENT: Routine

SAMPLE STABILITY: Indefinite

BLANKS: 10% of samples (minimum 2)

STANDARD ANALYTICAL ERROR: 0.25.

APPLICABILITY: The working range is 0.02 f/cc (1920-L air sample) to 1.25 f/cc (400-L air sample). The method gives an index of airborne asbestos fibers but may be used for other materials such as fibrous glass by inserting suitable parameters into the counting rules. The method does not differentiate between asbestos and other fibers. Asbestos fibers less than ca. 0.25 um diameter will not be detected by this method.

INTERFERENCES: Any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chainlike particles may appear fibrous. High levels of nonfibrous dust particles may obscure fibers in the field of view and raise the detection limit.

REAGENTS:

1. Acetone.
2. Triacetin (glycerol triacetate), reagent grade

SPECIAL PRECAUTIONS: Acetone is an extremely flammable liquid and precautions must be taken not to ignite it. Heating of acetone must be done in a ventilated laboratory fume hood using a flameless, spark-free heat source.

EQUIPMENT:

1. Collection device: 25-mm cassette with 50-mm electrically conductive extension cowl with cellulose ester filter, 0.8 to 1.2 mm pore size and backup pad.

Note: Analyze representative filters for fiber background before use and discard the filter lot if more than 5 fibers/100 fields are found.

2. Personal sampling pump, greater than or equal to 0.5 L/min. with flexible connecting tubing.
3. Microscope, phase contrast, with green or blue filter, 8 to 10X eyepiece, and 40 to 45X phase objective (total magnification ca 400X); numerical aperture = 0.65 to 0.75.
4. Slides, glass, single-frosted, pre-cleaned, 25 x 75 mm.
5. Cover slips, 25 x 25 mm, no. 1-1/2 unless otherwise specified by microscope manufacturer.
6. Knife, No. 1 surgical steel, curved blade.
7. Tweezers.
8. Flask, Guth-type, insulated neck, 250 to 500 mL (with single-holed rubber stopper and elbow-jointed glass tubing, 16 to 22 cm long).
9. Hotplate, spark-free, stirring type; heating mantle; or infrared lamp and magnetic stirrer.
10. Syringe, hypodermic, with 22-gauge needle.
11. Graticule, Walton-Beckett type with 100 um diameter circular field at the specimen plane (area = 0.00785 mm²), (Type G-22).

Note: The graticule is custom-made for each microscope.

12. HSE/NPL phase contrast test slide, Mark II.
13. Telescope, ocular phase-ring centering.
14. Stage micrometer (0.01 mm divisions).

SAMPLING

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Fasten the sampler to the worker's lapel as close as possible to the worker's mouth. Remove the top cover from the end of the cowl extension (open face) and orient face down. Wrap the joint between the extender and the monitor's body with shrink tape to prevent air leaks.
3. Submit at least two blanks (or 10% of the total samples, whichever is greater) for each set of samples. Remove the caps from the field blank cassettes and store the caps and cassettes in a clean area (bag or box) during the sampling period. Replace the caps in the cassettes when sampling is completed.
4. Sample at 0.5 L/min or greater. Do not exceed 1 mg total dust loading on the filter. Adjust sampling flow rate, Q (L/min), and time to produce a fiber density, E (fibers/mm²), of 100 to 1300 fibers/m² (3.85X10⁴ to 5X10⁵ fibers per 25-mm filter with effective collection area (A_c = 385 mm²)) for optimum counting precision (see step 21 below). Calculate the minimum sampling time, t_{minimum} (min) at the action level (one-half of the current standard), L (f/cc) of the fibrous aerosol being sampled:

$$t_{\text{minimum}} = \frac{(A_c)(E)}{(Q)(L) 10^3}$$

5. Remove the field monitor at the end of sampling, replace the plastic top cover and small end caps, and store the monitor.
6. Ship the samples in a rigid container with sufficient packing material to prevent jostling or damage.

Note: Do not use polystyrene foam in the shipping container because of electrostatic forces which may cause fiber loss from the sample filter.

SAMPLE PREPARATION

Note: The object is to produce samples with a smooth (non-grainy) background in a medium with a refractive index equal to or less than 1.46. The method below collapses the filter for

easier focusing and produces permanent mounts which are useful for quality control and interlaboratory comparison. Other mounting techniques meeting the above criteria may also be used, e.g., the nonpermanent field mounting technique used in P & CAM 239.

7. Ensure that the glass slides and cover slips are free of dust and fibers.
8. Place 40 to 60 ml of acetone into a Guth-type flask. Stopper the flask with a single-hole rubber stopper through which a glass tube extends 5 to 8 cm into the flask. The portion of the glass tube that exits the top of the stopper (8 to 10 cm) is bent downward in an elbow that makes an angle of 20 to 30 degrees with the horizontal.
9. Place the flask in a stirring hotplate or wrap in a heating mantle. Heat the acetone gradually to its boiling temperature (ca. 58° C).

CAUTION: The acetone vapor must be generated in a ventilated fume hood away from all open flames and spark sources. Alternate heating methods can be used, providing no open flame or sparks are present.

10. Mount either the whole sample filter or a wedge cut from the sample filter on a clean glass slide.
 - a. Cut wedges of ca. 25 percent of the filter area with a curved-blade steel surgical knife using a rocking motion to prevent tearing.
 - b. Place the filter or wedge, dust side up, on the slide. Static electricity will usually keep the filter on the slide until it is cleared.
 - c. Hold the glass slide supporting the filter approximately 1 to 2 cm from the glass tube port where the acetone vapor is escaping from the heated flask. The acetone vapor stream should cause a condensation spot on the glass slide ca. 2 to 3 cm in diameter. Move 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 45X phase objective.
- d. Place a stage micrometer on the microscope object stage and focus the microscope on the graduated 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 $L_o = 108 \text{ } \mu\text{m}$, $L_a = 2.93 \text{ mm}$ and $D = 100 \text{ } \mu\text{m}$, then $d_c = 2.71 \text{ mm}$.

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

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 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%

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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.

Note: To ensure good reproducibility, all laboratories engaged in asbestos counting are required to participate in the Proficiency Analytical Testing (PAT) Program and should routinely participate with other asbestos fiber counting laboratories in the exchange of field samples to compare performance of counters.

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:
- Count only fibers longer than 5 μm . Measure the length of curved fibers along the curve.
 - Count only fibers with a length-to-width ratio equal to or greater than 3:1.
 - For fibers that cross the boundary of the graticule field, do the following:
 - Count any fiber longer than 5 μm that lies entirely within the graticule area.
 - Count as 1/2 fiber any fiber with only one end lying within the graticule area.
 - Do not count any fiber that crosses the graticule boundary more than once.
 - Reject and do not count all other fibers.
 - 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. 1/6 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/ mm^2); by dividing the total fiber count, F ; minus the mean field blank count, B , by the number of fields, n_i ; and the field area, A_f (0.00785 mm^2 for a properly calibrated Walton-Beckett graticule):

$$(F/n_i) - (B/n_b)$$

$$E = \frac{\text{---}}{A_f} \text{ fibers/mm}^2$$

where: n_i - number of fields in submission sample
 n_b - number of fields in bulk samples

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 mm^2 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.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX C TO §1910.1001 - QUALITATIVE AND QUANTITATIVE FIT
TESTING PROCEDURES - MANDATORY

QUALITATIVE FIT TEST PROTOCOLS

I. ISOAMYL ACETATE PROTOCOL

A. Odor Threshold Screening

1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.
2. Odor-free water (e.g. distilled or spring water) at approximately 25° C shall be used for the solutions.
3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. This solution shall be prepared new at least weekly.
4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but shall not be connected to the same recirculating ventilation system.
5. The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.
6. A test blank is prepared in a third jar by adding 500 cc of odor free water.
7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically peeled, dried off and switched to maintain the integrity of the test.
8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e. 1 and 2): "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."
9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is per-

formed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test may not be used.
11. If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

B. Respirator Selection

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least five sizes of elastomeric half facepieces, from at least two manufacturers.
2. The selection process shall be conducted in a room separate from the fit-test chamber to prevent odor fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This instruction may not constitute the subject's formal training on respirator use, as it is only a review.
3. The test subject should understand that the employee is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape and, if fit properly and used properly will provide adequate protection.
4. The test subject holds each facepiece up to the face and eliminates those which obviously do not give a comfortable fit. Normally, selection will begin with a half-mask and if a good fit cannot be found, the subject will be asked to test the full facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)
5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. All donning and adjustments of the facepiece shall be performed

by the test subject without assistance from the test conductor or other person. Assistance in assessing comfort can be given by discussing the points in 1B6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:
 - Positioning of mask on nose.
 - Room for eye protection.
 - Room to talk.
 - Positioning mask on face and cheeks.
7. The following criteria shall be used to help determine the adequacy of the respirator fit:
 - Chin properly placed.
 - Strap tension.
 - Fit across nose bridge.
 - Distance from nose to chin.
 - Tendency to slip.
 - Self-observation in mirror.
8. The test subject shall conduct the conventional negative and positive-pressure fit checks (e.g. see ANSI Z88.2-1980). Before conducting the negative- or positive-pressure test the subject shall be told to "seat" the mask by rapidly moving the head from side-to-side and up and down, while taking a few deep breaths.
9. The test subject is now ready for fit testing.
10. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model of respirator shall be tried.
11. The employee shall be given the opportunity to select a different facepiece and be retested if the chosen facepiece becomes increasingly uncomfortable at any time.

C. Fit Test

1. The fit test chamber shall be similar to a clear 55 gal drum liner suspended inverted over a 2 foot diameter frame, so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.
2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.
3. After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.
4. A copy of the following test exercises and rainbow passage shall be taped to the inside of the test chamber:

Test Exercises

- 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. Inhale on each side. Be certain movement is complete. Do not bump the respirator against the shoulders.
- iv. Nod head up-and-down. Inhale when head is in the full up position (looking toward ceiling). Be certain motions are complete and made about every second. Do not bump the respirator on the chest.
- v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.
- vi. Jogging in place.
- vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

5. Each test subject shall wear the respirator for at least 10 minutes before starting the fit test.
6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous absorbent single ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.
7. Allow two minutes for the IAA test 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 1B4 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 facesal and takes a breath before exiting the chamber.
13. 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.
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 motions are complete. Inhale when head is in the full up position (when looking toward the ceiling). Do not bump the respirator on the chest.
 - v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.
 - vi. Jogging in place.

vii. Breathe normally.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

11. At the beginning of each exercise, the aerosol concentration shall be replenished using one-half the number of squeezes as initially described in C9.
12. The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.
13. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.
14. At least two facepieces shall be selected by the saccharin solution aerosol 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. Successful completion of the test protocol shall allow the use of the half mask tested respirator in contaminated atmospheres up to 10 times the PEL of asbestos. In other words this protocol may be used to assign protection factors no higher than ten.
16. The test shall not be conducted if there is any hair growth between the skin and 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.
3. The test conductor shall review this protocol with the test subject before testing.
4. The test subject shall perform the conventional positive pressure and negative pressure fit checks (see ANSI Z88.2 1980). Failure of either check shall be cause to select an alternate respirator.
5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part #5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.
6. Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep the eyes closed while the test is performed.

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 test conductor.
- (4) Respirators selected (indicate manufacturer, model, size and approval number).
- (5) Testing agent.

III. IRRITANT FUME PROTOCOL

A. Respirator selection

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a high-efficiency cartridge.

B. Fit test

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize the subject with the characteristic odor.
2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.

7. The test conductor shall direct the stream of irritant smoke from the tube towards the face seal area of the test subject. The person conducting the test shall begin with the tube at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.
8. The test subject shall be instructed to do the following exercises while the respirator is being challenged by the smoke. Each exercise shall be performed for one minute.
 - 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 motions are complete and made every second. Inhale when head is in the full up position (looking toward ceiling). Do not bump the respirator against the chest.
 - v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Repeating it after the test conductor (keeping eyes closed) will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

- vi. Jogging in Place.
- vii. Breathe normally.
9. The test subject shall indicate to the test conductor if the irritant smoke is detected. If smoke is detected, the test conductor shall stop the test. In this case, the tested respirator is rejected and another respirator shall be selected.
10. Each test subject passing the smoke test (i.e. without detecting the smoke) shall be given a sensitivity check of smoke from the same tube to determine if the test subject reacts to the smoke. Failure to evoke a response shall void the fit test.
11. Steps B4, B9, B10 of this fit test protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agents.
12. At least two facepieces shall be selected by the irritant fume 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.
13. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL of asbestos.
14. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.
15. 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.
16. 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.

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

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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, North 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.

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(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 test subject (keeping eyes closed) shall repeat after the test conductor the 'rainbow passage' at the end of this section. The subject shall talk slowly and aloud so as to be heard clearly by the test conductor or monitor.

f. Grimace (G). The test subject shall grimace, smile, frown, and generally contort the face using the facial muscles. Continue for at least 15 seconds.

g. Bend over and touch toes (B). The test subject shall bend at the waist and touch toes and return to upright position. Repeat for at least 30 seconds.

h. Jogging in place (J). The test subject shall perform jog in place for at least 30 seconds.

i. Normal Breathing (NB). Same as exercise a.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

6. The test shall be terminated whenever any single peak penetration exceeds 5 percent for half-masks and 1 percent for full facepieces. The test subject may be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate.

7. Calculation of Fit Factors.

- a. The fit factor determined by the quantitative fit test equals the average concentration inside the respirator.
- b. The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.
- c. The average peak concentration of the challenge agent inside the respirator shall be the arithmetic average peak concentrations for each of the nine exercises of the test which are computed as the arithmetic average of the peak concentrations found for each breath during the exercise.
- d. The average peak concentration for an exercise may be determined graphically if there is not a great variation in the peak concentrations during a single exercise.

8. Interpretation of Test Results. The fit factor measured by the quantitative fit testing shall be the lowest of the three protection factors resulting from three independent tests.

9. Other Requirements.

- a. The test subject shall not be permitted to wear a half-mask or full facepiece mask if the minimum fit factor of 100 or 1,000, respectively, cannot be obtained. 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.
- b. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface.
- c. 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.
- d. The test subject shall be given the opportunity to wear the assigned respirator for one week. If the respirator does not provide a satisfactory fit during actual use, the test subject may request another QNFT which shall be performed immediately.

e. A respirator fit factor card shall be issued to the test subject with the following information:

- (1) Name.
- (2) Date of fit test.
- (3) Protection factors obtained through each manufacturer, model and approval number of respirator tested.
- (4) Name and signature of the person that conducted the test.

f. Filters used for qualitative or quantitative fit testing shall be replaced weekly, whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily or sooner if there is any indication of breakthrough by the test agent.

10. In addition, because the sealing of the respirator may be affected, quantitative 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.

11. Recordkeeping.

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

- (1) Name of test subject.
- (2) Date of testing.
- (3) Name of the test conductor.
- (4) Fit factors obtained from every respirator tested (indicate manufacturer, model, size and approval number).

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-Temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-Perm).
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

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APPENDIX D to §1910.1001 - MEDICAL QUESTIONNAIRES - MANDATORY

This **mandatory** appendix contains the medical questionnaires that must be administered to all employees who are exposed to asbestos above the action level, and who will therefore be included in their employer's medical surveillance program. Part 1 of the appendix contains the Initial Medical Questionnaire, which must be obtained for all new hires who will be covered by the medical surveillance requirements.

Part 2 includes the abbreviated Periodical Medical Questionnaire, which must be administered to all employees who are provided periodic medical examinations under the medical surveillance provisions of the standard.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).
OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

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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?..... | <input type="checkbox"/> | <input type="checkbox"/> |
| F. In a quarry?..... | <input type="checkbox"/> | <input type="checkbox"/> |
| G. In a foundry?..... | <input type="checkbox"/> | <input type="checkbox"/> |
| H. In a pottery?..... | <input type="checkbox"/> | <input type="checkbox"/> |
| I. In a cotton, flax or hemp mill?..... | <input type="checkbox"/> | <input type="checkbox"/> |
| J. With asbestos?..... | <input type="checkbox"/> | <input type="checkbox"/> |

18. PAST MEDICAL HISTORY

- | | YES | NO |
|---|--------------------------|--------------------------|
| A. Do you consider yourself to be in good health? | <input type="checkbox"/> | <input type="checkbox"/> |

If "NO" state reason _____

- | | | |
|--|--------------------------|--------------------------|
| B. Have you any defect of vision?..... | <input type="checkbox"/> | <input type="checkbox"/> |
|--|--------------------------|--------------------------|

If "YES" state nature of defect _____

- | | | |
|--------------------------------------|--------------------------|--------------------------|
| C. Have you any hearing defect?..... | <input type="checkbox"/> | <input type="checkbox"/> |
|--------------------------------------|--------------------------|--------------------------|

If "YES" state nature of defect _____

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

- | | | |
|---|--------------------------|--------------------------|
| a. Epilepsy (or fits, seizures, convulsions)? | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Rheumatic fever? | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Kidney disease? | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Bladder disease? | <input type="checkbox"/> | <input type="checkbox"/> |
| e. Diabetes? | <input type="checkbox"/> | <input type="checkbox"/> |
| f. Jaundice? | <input type="checkbox"/> | <input type="checkbox"/> |

19. CHEST COLDS AND CHEST ILLNESSES

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

- 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 ___

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- B. Any chest operations? 1. Yes 2. No
 If yes, please specify _____
- C. Any chest injuries? 1. Yes 2. No
 If yes, please specify _____
- 27A. Has a doctor ever told you that you had heart trouble? 1. Yes 2. No
 IF YES TO 27A:
 B. Have you ever had treatment for heart trouble in the past 10 years? 1. Yes 2. No 3. Does Not Apply
- 28A. Has a doctor ever told you that you had high blood pressure? 1. Yes 2. No
 IF YES TO 28A:
 B. Have you had any treatment for high blood pressure (hypertension) in the past 10 years? 1. Yes 2. No 3. Does Not Apply
29. When did you last have your chest X-rayed? (Year) 25 26 27 28
30. Where did you last have your chest X-rayed (if known)? _____
 What was the outcome? _____

FAMILY HISTORY

31. Were either of your natural parents ever told by a doctor that they had a chronic lung condition such as:

	FATHER			MOTHER		
	1. Yes	2. No	3. Don't Know	1. Yes	2. No	3. Don't Know
A. Chronic Bronchitis?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Emphysema?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. Asthma?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Lung cancer?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. Other chest conditions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
F. Is parent currently alive?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
G. Please Specify	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/> Age if Living			<input type="checkbox"/> Age if Living	
		<input type="checkbox"/> Age at Death			<input type="checkbox"/> Age at Death	
		<input type="checkbox"/> Don't Know			<input type="checkbox"/> Don't Know	
H. Please specify cause of death	_____			_____		

- 32A. Do you usually have a cough? (Count a cough with first smoke or on first going out of doors. Exclude clearing of throat.) [If no, skip to question 32C.] 1. Yes 2. No
- B. Do you usually cough as much as 4 to 6 times a day 4 or more days out of the week? 1. Yes 2. No
- C. Do you usually cough at all on getting up or first thing in the morning? 1. Yes 2. No

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- D. Do you usually cough at all during the rest of the day or at night? 1. Yes ___ 2. No ___

IF YES TO ANY OF ABOVE (32A, B, C, or D). ANSWER THE FOLLOWING. IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO NEXT PAGE

- E. Do you usually cough like this on most days for 3 consecutive months or more during the year? 1. Yes ___ 2. No ___ 3. Does not apply ___
- F. For how many years have you had the cough? Number of years ___ Does not apply ___
- 33A. Do you usually bring up phlegm from your chest? (Count phlegm with the first smoke or on first going out of doors. Exclude phlegm from the nose. Count swallowed phlegm.) (If no, skip to 33C) 1. Yes ___ 2. No ___
- B. Do you usually bring up phlegm like this as much as twice a day 4 or more days out of the week? 1. Yes ___ 2. No ___
- C. Do you usually bring up phlegm at all on getting up or first thing in the morning? 1. Yes ___ 2. No ___
- D. Do you usually bring up phlegm at all during the rest of the day or at night? 1. Yes ___ 2. No ___

IF YES TO ANY OF THE ABOVE (33A, B, C, or D), ANSWER THE FOLLOWING: IF NO TO ALL, CHECK DOES NOT APPLY AND SKIP TO 34A.

- E. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year? 1. Yes ___ 2. No ___ 3. Does not apply ___
- F. For how many years have you had trouble with phlegm? Number of years ___ Does not apply ___

EPISODES OF COUGH AND PHLEGM

- 34A. Have you had periods or episodes of (increased*) cough and phlegm lasting for 3 weeks or more each year? *(For persons who usually have cough and/or phlegm) 1. Yes ___ 2. No ___
- If YES TO 34A
- B. For how long have you had at least 1 such episode per year? Number of years ___ Does not apply ___

WHEEZING

- 35A. Does your chest ever sound wheezy or whistling
1. When you have a cold? 1. Yes ___ 2. No ___
2. Occasionally apart from colds? 1. Yes ___ 2. No ___
3. Most days or nights? 1. Yes ___ 2. No ___
- If YES TO 1, 2, or 3 in 35A
- B. For how many years has this been present? Number of years ___ Does not apply ___
- 36A. Have you ever had an attack of wheezing that has made you feel short of breath? 1. Yes ___ 2. No ___
- If YES TO 36A
- B. How old were you when you had your first such attack? Age in years ___ Does not apply ___
- C. Have you had 2 or more such episodes? 1. Yes ___ 2. No ___ 3. Does not apply ___
- D. Have you ever required medicine or treatment for the(se) attack(s)? 1. Yes ___ 2. No ___ 3. Does not apply ___

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BREATHLESSNESS

37. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to question 39A.

Nature of condition(s) _____

38A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ___ 2. No ___

IF YES TO 38A

B. Do you have to walk slower than people of your age on the level because of breathlessness? 1. Yes ___ 2. No ___ 3. Does not apply ___

C. Do you ever have to stop for breath when walking at your own pace on the level? 1. Yes ___ 2. No ___ 3. Does not apply ___

D. Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level? 1. Yes ___ 2. No ___ 3. Does not apply ___

E. Are you too breathless to leave the house or breathless on dressing or climbing one flight of stairs? 1. Yes ___ 2. No ___ 3. Does not apply ___

TOBACCO SMOKING

39A. Have you ever smoked cigarettes? (No means less than 20 packs of cigarettes or 12 oz. of tobacco in a lifetime or less than 1 cigarette a day for 1 year.) 1. Yes ___ 2. No ___

IF YES TO 39A

B. Do you now smoke cigarettes (as of one month ago) 1. Yes ___ 2. No ___ 3. Does not apply ___

C. How old were you when you first started regular cigarette smoking? Age in years _____ Does not apply ___

D. If you have stopped smoking cigarettes completely, how old were you when you stopped? Age stopped _____
Check if still smoking ___
Does not apply ___

E. How many cigarettes do you smoke per day now? Cigarettes per day ___
Does not apply ___

F. On the average of the entire time you smoked, how many cigarettes did you smoke per day? Cigarettes per day ___
Does not apply ___

5 G. Do or did you inhale the cigarette smoke? 1. Does not apply ___
2. Not at all ___
3. Slightly ___
4. Moderately ___
5. Deeply ___

40A. Have you ever smoked a pipe regularly? (Yes means more than 12 oz. of tobacco in a lifetime.) 1. Yes ___ 2. No ___

IF YES TO 40A:

FOR PERSONS WHO HAVE EVER SMOKED A PIPE

B. 1. How old were you when you started to smoke a pipe regularly? Age _____

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2. If you have stopped smoking a pipe completely, how old were you when you stopped? Age stopped _____
Check if still smoking pipe _____
Does not apply _____
- C. On the average over the entire time you smoked a pipe, how much pipe tobacco did you smoke per week? _____ oz. per week (a standard pouch of tobacco contains 1-1/2 oz.)
Does not apply _____
- D. How much pipe tobacco are you smoking now? oz. per week _____
Not currently smoking a pipe _____
- E. Do you or did you inhale the pipe smoke?
1. Never smoked _____
2. Not at all _____
3. Slightly _____
4. Moderately _____
5. Deeply _____
- 41A. Have you ever smoked cigars regularly? (Yes means more than 1 cigar a week for a year)
1. Yes _____ 2. No _____

IF YES TO 41A

FOR PERSONS WHO HAVE EVER SMOKED CIGARS

- B. 1. How old were you when you started smoking cigars regularly? Age _____
2. If you have stopped smoking cigars completely, how old were you when you stopped. Age stopped _____
Check if still smoking cigars _____
Does not apply _____
- C. On the average over the entire time you smoked cigars, how many cigars did you smoke per week? Cigars per week _____
Does not apply _____
- D. How many cigars are you smoking per week now? Cigars per week _____
Check if not smoking cigars currently _____
- E. Do or did you inhale the cigar smoke?
1. Never smoked _____
2. Not at all _____
3. Slightly _____
4. Moderately _____
5. Deeply _____

Date _____

Signature _____

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14. CHEST COLDS AND CHEST ILLNESSES

- 14A. 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 ___
- 15A. During the past year, have you had any chest illnesses
that have kept you off work, indoors at home, or in bed? 1. Yes ___ 2. No ___ 3. Does Not Apply ___
- IF YES TO 15A:
- 15B. Did you produce phlegm with any of these chest illnesses? 1. Yes ___ 2. No ___ 3. Does Not Apply ___
- 15C. In the past year, how many such illnesses with (increased)
phlegm did you have which lasted a week or more? Number of illnesses ___ No such illnesses ___

16. RESPIRATORY SYSTEM

In the past year have you had:

	<u>Yes or No</u>	<u>Further Comment on Positive Answers</u>
Asthma	_____	
Bronchitis	_____	
Hay Fever	_____	
Other Allergies	_____	

Yes or No Further Comment on Positive Answers

Pneumonia	_____
Tuberculosis	_____
Chest Surgery	_____
Other Lung Problems	_____
Heart Disease	_____

Do you have:

Yes or No Further Comment on Positive Answers

Frequent colds	_____
Chronic cough	_____
Shortness of breath when walking or climbing one flight of stairs	_____

Do you:

Wheeze	_____
--------	-------

Cough up phlegm	_____
-----------------	-------

Smoke cigarettes	_____	Packs per day _____	How many years _____
------------------	-------	---------------------	----------------------

Date _____

Signature _____

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX E to §1910.1001 - INTERPRETATION AND CLASSIFICATION OF
CHEST ROENTGENOGRAMS - MANDATORY

- (a) Chest roentgenograms shall be interpreted and classified in accordance with a professionally accepted Classification system and recorded on an interpretation form following the format of the CDC/NIOSH (M) 2.8 form. As a minimum, the content within the bold lines of this form (items 1 through 4) shall be included. This form is not to be submitted to NIOSH.
- (b) Roentgenograms shall be interpreted and classified only by a B-reader, a board eligible/certified radiologist, or an experienced physician with known expertise in pneumoconioses.
- (c) All interpreters, whenever interpreting chest roentgenograms made under this section, shall have immediately available for reference a complete set of the ILO-U/C International Classification of Radiographs for Pneumoconioses, 1980.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX F to §1910.1001 - WORK PRACTICES AND ENGINEERING CONTROLS
FOR AUTOMOTIVE BRAKE REPAIR OPERATIONS - NON-MANDATORY

This appendix is intended as guidance for employers in the automotive brake and clutch repair industry who wish to reduce their employees' asbestos exposures during repair operations to levels below the new standard's action level (0.1 f/cc). OSHA believes that employers in this industry sector are likely to be able to reduce their employees' exposures to asbestos by employing the engineering and work practice controls described in Sections A and B of this appendix. Those employers who choose to use these controls and who achieve exposures below the action level will thus be able to avoid any burden that might be imposed by complying with such requirements as medical surveillance, recordkeeping, training, respiratory protection, and regulated areas, which are triggered when employee exposures exceed the action level or PEL.

Asbestos exposure in the automotive brake and clutch repair industry occurs primarily during the replacement of clutch plates and brake pads, shoes, and linings. Asbestos fibers may become airborne when an automotive mechanic removes the asbestos-containing residue that has been deposited as brakes and clutches wear. Employee exposures to asbestos occur during the cleaning of the brake drum or clutch housing.

Based on evidence in the rulemaking record (Exs. 84-74, 84-263, 90-148), OSHA believes that employers engaged in brake repair operations who implement any of the work practices and engineering controls described in Sections A and B of this appendix may be able to reduce their employees' exposures to levels below the action level (0.1 fiber/cc). These control methods and the relevant record evidence on these and other methods are described in the following sections.

A. Enclosed Cylinder/HEPA Vacuum System Method

The enclosed cylinder-vacuum system used in one of the facilities visited by representatives of the National Institute for Occupational Safety and Health (NIOSH) during a health hazard evaluation of brake repair facilities (Ex. 84-263) consists of three components:

- (1) A wheel-shaped cylinder designed to cover and enclose the wheel assembly;
- (2) A compressed-air hose and nozzle that fits into a port in the cylinder; and
- (3) A HEPA-filtered vacuum used to evacuate airborne dust generated within the cylinder by the compressed air.

To operate the system, the brake assembly is enclosed in a cylinder that has viewing ports to provide visibility and cotton sleeves through which the mechanic can handle the brake assembly parts. The cylinder effectively isolates asbestos dust in the drum from the mechanic's breathing zone. One company manufactures the brake assembly isolation cylinder in two sizes to fit brake drums in the 7-to-12-inch size range common to automobiles and light trucks and the 12-to-19-inch size range common to large commercial vehicles. The cylinder is equipped with built-in compressed-air guns and a connection for a vacuum cleaner equipped with a High Efficiency Particulate Air (HEPA) filter. This type of filter is capable of removing all particles greater than 0.3 microns from the air. When the vacuum cleaner's filter is full, it must be replaced according to the manufacturer's instruction, and appropriate HEPA-filtered dual cartridge respirators should be worn during the process. The filter of the vacuum cleaner is assumed to be contaminated with asbestos fibers and should be handled carefully, wetted with a fine mist of water, placed immediately in a labelled plastic bag, and disposed of properly. When the cylinder is in place around the brake assembly and the HEPA vacuum is connected, compressed air is blown into the cylinder to loosen the residue from the brake assembly parts. The vacuum then evacuates the loosened material from within the cylinder, capturing the airborne material on the HEPA filter.

The HEPA vacuum system can be disconnected from the brake assembly isolation cylinder when the cylinder is not being used. The HEPA vacuum can then be used for clutch facing work, grinding, or other routine cleaning.

B. Compressed Air/Solvent System Method

A compressed-air hose fitted at the end with a bottle of solvent can be used to loosen the asbestos-containing residue and to capture the resulting airborne particles in the solvent mist. The mechanic should begin spraying the asbestos-contaminated parts with the solvent at a sufficient distance to ensure that the asbestos particles are not dislodged by the velocity of the solvent spray. After the asbestos particles are thoroughly wetted, the spray may be brought closer to the parts and the parts may be sprayed as necessary to remove grease and other material. The automotive parts sprayed with the mist are then wiped with a rag, which must then be disposed of appropriately. Rags should be placed in a labelled plastic bag or other container while they are still wet. This ensures that the asbestos fibers will not become airborne after the brake and clutch parts have been cleaned. (If

cleanup rags are laundered rather than disposed of, they must be washed using methods appropriate for the laundering of asbestos-contaminated materials.)

OSHA believes that a variant of this compressed-air/solvent mist process offers advantages over the compressed-air/solvent mist technique discussed above, both in terms of costs and employee protection. The variant involves the use of spray cans filled with any of several solvent cleaners commercially available from auto supply stores. Spray cans of solvent are inexpensive, readily available, and easy to use. These cans will also save time, because no solvent delivery system has to be assembled, i.e., no compressed-air hose/mister ensemble. OSHA believes that a spray can will deliver solvent to the parts to be cleaned with considerably less force than the alternative compressed-air delivery system described above, and will thus generate fewer airborne asbestos fibers than the compressed-air method. The Agency therefore believes that the exposure levels of automotive repair mechanics using the spray can/solvent mist process will be even lower than the exposures reported by NIOSH (Ex. 84-263) for the compressed-air/solvent mist system (0.08 f/cc).

C. Information on the Effectiveness of Various Control Measures

The amount of airborne asbestos generated during brake and clutch repair operations depends on the work practices and engineering controls used during the repair or removal activity. Data in the rulemaking record document the 8-hour time-weighted average (TWA8) asbestos exposure levels associated with various methods of brake and clutch repair and removal.

NIOSH submitted a report to the record entitled "Health Hazard Evaluation for Automotive Brake Repair" (Ex. 84-263). In addition, Exhibits 84-74 and 90-148 provided exposure data for comparing the airborne concentrations of asbestos generated by the use of various work practices during brake repair operations. These reports present exposure data for brake repair operations involving a variety of controls and work practices, including:

- Use of compressed air to blow out the brake drums;
- Use of a brush, without a wetting agent, to remove the asbestos-containing residue;
- Use of a brush dipped in water or a solvent to remove the asbestos-containing residue;
- Use of an enclosed vacuum cleaning system to capture the asbestos-containing residue; and
- Use of a solvent mixture applied with compressed air to remove the residue.

Prohibited Methods

The use of compressed air to blow the asbestos-containing residue off the surface of the brake drum removes the residue effectively but simultaneously produces an airborne cloud of asbestos fibers. According to NIOSH (Ex. 84-263), the peak exposures of mechanics using this technique were as high as 15 fibers/cc, and 8-hour TWA exposures ranged from 0.03 to 0.19 f/cc.

Dr. William J. Nicholson of the Mount Sinai School of Medicine (Ex. 84-74) cited data from Knight and Hickish (1970) that indicated that the concentration of asbestos ranged from 0.84 to 5.35 f/cc over a 60-minute sampling period when compressed air was being used to blow out the asbestos-containing residue from the brake drum. In the same study, a peak concentration of 87 f/cc was measured for a few seconds during brake cleaning performed with compressed air. Rohl et al. (1976) (Ex. 90-148) measured area concentrations (of unspecified duration) within 3-5 feet of operations involving the cleaning of brakes with compressed air and obtained readings ranging from 6.6 to 29.8 f/cc. Because of the high exposure levels that result from cleaning brake and clutch parts using compressed air, OSHA has prohibited this practice in the revised standard.

Ineffective Methods

When dry brushing was used to remove the asbestos-containing residue from the brake drums and wheel assemblies, peak exposures measured by NIOSH ranged from 0.61 to 0.81 f/cc, while 8-hour TWA levels were at the new standard's permissible exposure limit (PEL) of 0.2 f/cc (Ex. 84-263). Rohl and his colleagues (Ex. 90-148) collected area samples 1-3 feet from a brake cleaning operation being performed with a dry brush, and measured concentrations ranging from 1.3 to 3.6 f/cc; however, sampling times and TWA concentrations were not presented in the Rohl et al. study.

When a brush wetted with water, gasoline, or Stoddart solvent was used to clean the asbestos-containing residue from the affected parts, exposure levels (8-hour TWAs) measured by NIOSH also exceeded the new 0.2 f/cc PEL, and peak exposures ranged as high as 2.62 f/cc (Ex. 84-263).

Preferred Methods

Use of an engineering control system involving a cylinder that completely encloses the brake shoe assembly and a High Efficiency Particulate Air (HEPA) filter-equipped vacuum produced 8-hour TWA employee exposures of 0.01 f/cc and peak exposures ranging from nondetectable to 0.07 f/cc (Ex. 84-263). (Because this system achieved exposure levels below the standard's action level, it is described in detail above.) Data collected by the Mount Sinai Medical Center (Ex. 90-148) for Nilfisk of America, Inc., the manufacturer of the brake assembly enclosure system, showed that for two of three operations sampled, the exposure of mechanics to airborne asbestos fibers was nondetectable. For the third operator sampled by Mt. Sinai researchers, the exposure was 0.5 f/cc, which the authors attributed to asbestos that had contaminated the operator's clothing in the course of previous brake repair operations performed without the enclosed cylinder/vacuum system.

Some automotive repair facilities use a compressed-air hose to apply a solvent mist to remove the asbestos-containing residue from the brake drums before repair. The NIOSH data (Ex. 84-263) indicated that mechanics employing this method experienced exposures (8-hour TWAs) of 0.8 f/cc, with peaks of 0.25 to 0.68 f/cc. This technique, and a variant of it that OSHA believes is both less costly and more effective in reducing employee exposures, is described in greater detail above in Sections A and B.

D. Summary

In conclusion, OSHA believes that it is likely that employers in the brake and clutch repair industry will be able to avail themselves of the action level trigger built into the revised standard if they conscientiously employ one of the three control methods described above: the enclosed cylinder/HEPA vacuum system, the compressed air/solvent method, or the spray can/solvent mist system.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX G to §1910.1001 - 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 is 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 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 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 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 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 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 exposure, or where engineering controls are not feasible to reduce asbestos exposure. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos 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 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 wear protective clothing in work areas where asbestos fiber concentrations exceed the permissible exposure limit (PEL) of 0.2 f/cc to prevent contamination of the skin. Where protective clothing is required, your employer must provide you with clean garments. Unless you are working on a large asbestos removal or demolition project, your employer must also provide a change room and separate lockers for your street clothes and contaminated work clothes. If you are working on a large asbestos removal or demolition project, and where it is feasible to do so, your employer must provide a clean room, shower, and decontamination room contiguous to the work area. When leaving the work area, you must remove contaminated clothing before proceeding to the shower. If the shower is not adjacent to the work area, you must vacuum your clothing before proceeding to the change room and shower. To prevent inhaling fibers in contaminated change rooms and showers, leave your respirator on until you leave the shower and enter the clean change room.

IV. Disposal Procedures and Cleanup

- A. Wastes that are generated by processes where asbestos are present include:
1. Empty asbestos shipping containers.
 2. Process wastes such as cuttings, trimmings, or reject material.
 3. Housekeeping waste from sweeping or vacuuming.
 4. Asbestos fireproofing or insulating material that is removed from buildings.
 5. Building products that contain asbestos removed during building renovation or demolition.
 6. Contaminated disposable protective clothing.
- B. Empty shipping bags can be flattened under exhaust hoods and packed into airtight containers for disposal. Empty shipping drums are difficult to clean and should be sealed.
- C. Vacuum bags or disposable paper filters should not be cleaned, but should be sprayed with a fine water mist and placed into a labeled waste container.
- D. Process waste and housekeeping waste should be wetted with water or a mixture of water and surfactant prior to packaging in disposable containers.
- E. Material containing asbestos that is removed from buildings must be disposed of in leak-tight 6-mil thick plastic bags, plastic-lined cardboard containers, or plastic-lined metal containers. These wastes, which are removed while wet, should be sealed in containers before they dry out to minimize the release of asbestos fibers during handling.

V. Access to Information

- A. Each year, your employer is required to inform you of the information contained in this standard and appendices for asbestos. In addition, your employer must instruct you in the proper work practices for handling materials containing asbestos and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to asbestos. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure, and, if you are exposed above the permissible limit, he or she is required to inform you of the actions that are being taken to reduce your exposure to within the permissible limit.
- C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept for at least thirty (30) years. Medical records must be kept for the period of your employment plus thirty (30) years.
- D. Your employer is required to release your exposure and medical records to your physician or designated representative upon your written request.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

APPENDIX H to §1910.1001 - MEDICAL SURVEILLANCE GUIDELINES FOR
ASBESTOS - NON-MANDATORY

I. Route of Entry Inhalation, Ingestion

II. Toxicology

Clinical evidence of the adverse effects associated with exposure to asbestos is present in the form of several well-conducted epidemiological studies of occupationally exposed workers, family contacts of workers, and persons living near asbestos mines. These studies have shown a definite association between exposure to asbestos and an increased incidence of lung cancer, pleural and peritoneal mesothelioma, gastrointestinal cancer, and asbestosis. The latter is a disabling fibrotic lung disease that is caused only by exposure to asbestos. Exposure to asbestos has also been associated with an increased incidence of esophageal, kidney, laryngeal, pharyngeal, and buccal cavity cancers. As with other known chronic occupational diseases, disease associated with asbestos generally appears about 20 years following the first occurrence of exposure: There are no known acute effects associated with exposure to asbestos.

Epidemiological studies indicate that the risk of lung cancer among exposed workers who smoke cigarettes is greatly increased over the risk of lung cancer among non-exposed smokers or exposed nonsmokers. These studies suggest that cessation of smoking will reduce the risk of lung cancer for a person exposed to asbestos but will not reduce it to the same level of risk as that existing for an exposed worker who has never smoked.

III. Signs and Symptoms of Exposure-Related Disease

The signs and symptoms of lung cancer or gastrointestinal cancer induced by exposure to asbestos are not unique, except that a chest X-ray of an exposed patient with lung cancer may show pleural plaques, pleural calcification, or pleural fibrosis. Symptoms characteristic of mesothelioma include shortness of breath, pain in the walls of the chest, or abdominal pain. Mesothelioma has a much longer latency period compared with lung cancer (40 years versus 15-20 years), and mesothelioma is therefore more likely to be found among workers who were first exposed to asbestos at an early age. Mesothelioma is always fatal.

Asbestosis is pulmonary fibrosis caused by the accumulation of asbestos fibers in the lungs. Symptoms include shortness of breath, coughing, fatigue, and vague feelings of sickness. When the fibrosis worsens, shortness of breath occurs even at rest. The diagnosis of asbestosis is based on a history of exposure to asbestos, the presence of characteristic radiologic changes, end-inspiratory crackles (rales), and other clinical features of fibrosing lung disease. Pleural plaques and thickening are observed on X-rays taken during the early stages of the disease. Asbestosis is often a progressive disease even in the absence of continued exposure, although this appears to be a highly individualized characteristic. In severe cases, death may be caused by respiratory or cardiac failure.

IV. Surveillance and Preventive Considerations

As noted above, exposure to asbestos has been linked to an increased risk of lung cancer, mesothelioma, gastrointestinal cancer, and asbestosis among occupationally exposed workers. Adequate screening tests to determine an employee's potential for developing serious chronic diseases, such as cancer, from exposure to asbestos do not presently exist. However, some tests, particularly chest X-rays and pulmonary function tests, may indicate that an employee has been overexposed to asbestos increasing his or her risk of developing exposure-related chronic diseases. It is important for the physician to become familiar with the operating conditions in which occupational exposure to asbestos is likely to occur. This is particularly important in evaluating medical and work histories and in conducting physical examinations. When an active employee has been identified as having been overexposed to asbestos measures taken 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 or a combination of these minerals at or above the action level (0.1 fiber per cubic centimeter of air). 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.

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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; 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 exposure that require further explanation or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to exposure to asbestos and a copy of the opinion must be provided to the affected employee.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 4-1989, f. 3/31/89, ef. 5/1/89 (Asbestos-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Asbestos-perm).

OR-OSHA Admin. Order 3-1990, f. 1/19/90, ef. 1/19/90 (temp).

OR-OSHA Admin. Order 7-1990, f. 3/2/90, ef. 3/2/90 (perm).

OR-OSHA Admin. Order 7-1991, f. 4/25/91, ef. 4/25/91.

OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.

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APPENDIX I to §1910.1001 - SMOKING CESSATION PROGRAM INFORMATION
FOR ASBESTOS - NON-MANDATORY

The following organizations provide smoking cessation information and program material.

1. The National Cancer Institute operates a toll-free Cancer Information Service (CIS) with trained personnel to help you. Call 1-800-4-CANCER* to reach the CIS office serving your area, or write: Office of Cancer Communications, National Cancer Institute, National Institutes of Health, Building 31, Room 10A24, Bethesda, Maryland 20892.
2. American Cancer Society, 3340 Peachtree Road, NE., Atlanta, Georgia 30062, (404) 320-3333.

The American Cancer Society (ACS) is a voluntary organization composed of 58 divisions and 3,100 local units. Through "The Great American Smokeout" in November, the annual Cancer Crusade in April, and numerous educational materials, ACS helps people learn about the health hazards of smoking and become successful ex-smokers.

3. American Heart Association, 7320 Greenville Avenue, Dallas, Texas 75231, (214) 750-5300.

The American Heart Association (AHA) is a voluntary organization with 130,000 members (physicians, scientists, and laypersons) in 55 state and regional groups. AHA produces a variety of publications and audiovisual materials about the effects of smoking on the heart. AHA also has developed a guidebook for incorporating a weight-control component into smoking cessation programs.

4. American Lung Association, 1740 Broadway, New York, New York 10019, (212) 245-8000.

A voluntary organization of 7,500 members (physicians, nurses, and laypersons), the American Lung Association (ALA) conducts numerous public information programs about the health effect of smoking. AIA has 59 state and 85 local units. The organization actively supports legislation and information campaigns for non-smokers' rights and provides help for smokers who want to quit, for example, through "Freedom From Smoking," a self-help smoking cessation program.

5. Office on Smoking and Health, U.S. Department of Health and Human Services, 5600 Fishers Lane, Park Building, Room 110, Rockville, Maryland 20857.

The Office on Smoking and Health (OSH) is the Department of Health and Human Services' lead agency in smoking control. OSH has sponsored distribution of publications on smoking-related topics, such as free flyers on relapse after initial quitting, helping a friend or family member quit smoking, the health hazards of smoking, and the effects of parental smoking on teenagers.

*In Hawaii, on Oahu call 5240-1234 (call collect from neighboring islands).

Spanish-speaking staff members are available during daytime hours to callers from the following areas: California, Florida, Georgia, Illinois, New Jersey (area code 210), New York, and Texas. Consult your local telephone directory for listings of local chapters.

(Reporting and recordkeeping requirements in paragraphs (d)(2), (3), (5), and (7), (f)(2) and (g)(3)(i), (j)(5), (l), and (m) as they apply to the excursion limit have been approved by the Office of Management and Budget under control numbers 1218-0133 and 1218-0134. The OMB clearance expires on February 29, 1992.)

(Reporting and recordkeeping requirements in paragraph (j)(5)(iv)(C) have received OMB paperwork clearance under OMB clearance number 1218-0133. The OMB clearance expires on April 30, 1993.)

(Approved by the Office of Management and Budget under control number 1218-0133)

(51 FR 22733, June 20, 1986, as amended at 51 FR 37004, Oct. 17, 1986; 52 FR 17754, 17755, May 12, 1987; 53 FR 35625, September 14, 1988; 54 FR 24334, June 7, 1989; 54 FR 29546, July 13, 1989; 54 FR 30705, July 21, 1989; 54 FR 52027, Dec. 20, 1989; 55 FR 3731, Feb. 5, 1990; 55 FR 34710, Aug. 24, 1990; 55 FR 50687, Dec. 10, 1990; 57 FR 24310, June 8, 1992.)

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: OR-OSHA Admin. Order 13-1990, f. 6/28/90, ef. 8/1/90 (temp).
OR-OSHA Admin. Order 19-1990, f. 8/31/91, ef. 8/31/91 (perm).

OREGON ADMINISTRATIVE RULES
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§1910.1101 ASBESTOS.

NOTE: 1910.1101, **Asbestos** (pertaining to Non-Asbestiform Minerals) was repealed by OR-OSHA Admin. Order 11-1992, filed 10/9/92, EFFECTIVE 10/9/92.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: APD Admin. Order 6-1989, f. 4/20/89, ef. 5/1/89 (Non-Asbestiforms-temp).

APD Admin. Order 9-1989, f. 7/7/89, ef. 7/7/89 (Non-Asbestiforms-perm).

OR-OSHA Admin. Order 3-1990, f. 1/19/90, ef. 1/19/90 (temp).

OR-OSHA Admin. Order 7-1990, f. 3/2/90, ef. 3/2/90 (perm).

OR-OSHA Admin. Order 7-1991, f. 4/25/91, ef. 4/25/91.

Repealed by OR-OSHA Admin. Order 11-1992, f. 10/9/92, ef. 10/9/92.