AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
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(2) Except as provided in paragraph (m)(3) of this section, the Assistant Secretary shall not approve a request for an inter-agency transfer of personally identifiable employee medical information, which has not been consented to by the affected employees, unless the request is by a public health agency which:

(i) Needs the requested information in a personally identifiable form for a substantial public health purpose,

(ii) Will not use the requested information to make individual determinations concerning affected employees which could be to their detriment,

(iii) Has regulations or established written procedures providing protection for personally identifiable medical information substantially equivalent to that of this section, and

(iv) Satisfies an exemption to the Privacy Act to the extent that the Privacy Act applies to the requested information (*See*, 5 U.S.C. 552a(b); 29 CFR 70a.3).

(3) Upon the approval of the Assistant Secretary, personally identifiable employee medical information may be transferred to:

(i) The National Institute for Occupational Safety and Health (NIOSH) and

(ii) The Department of Justice when necessary with respect to a specific action under the Occupational Safety and Health Act.

(4) The Assistant Secretary shall not approve a request for public disclosure of employee medical information containing direct personal identifiers unless there are compelling circumstances affecting the health or safety of an individual.

(5) The Assistant Secretary shall not approve a request for public disclosure of employee medical information which contains information which could reasonably be used indirectly to identify specific employees when the disclosure would constitute a clearly unwarranted invasion of personal privacy (*See*, 5 U.S.C. 552(b)(6); 29 CFR 70.26).

(6) Except as to inter-agency transfers to NIOSH or the Department of Justice, the OSHA Medical Records Officer shall assure that advance notice is provided to any collective bargaining agent representing affected employees and to the employer on each occasion that OSHA intends to either transfer personally identifiable employee medical information to another agency or disclose it to a member of the public other than to an affected employee. When feasible, the OSHA Medical Records Officer shall take reasonable steps to assure that advance notice is provided to affected employees when the employee medical information to be transferred or disclosed contains direct personal identifiers.

(n) *Effective date*. This section shall become effective on August 21, 1980.

[45 FR 35294, May 23, 1980; 45 FR 54334, Aug. 15, 1980]

PART 1915—OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR SHIPYARD EMPLOYMENT

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AUTHORITY: Section 41, Longshore and Harbor Workers' Compensation Act (33 U.S.C. 941); secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), or 6–96 (62 FR 111), as applicable.

Sections 1915.120 and 1915.152 also issued under 29 CFR 1911.

SOURCE: 47 FR 16986, Apr. 20, 1982, unless otherwise noted.

Subpart A—General Provisions

§ 1915.1 Purpose and authority.

The provisions in this part constitute safety and health regulations issued by the Secretary pursuant to section 41 of the Longshoremen's and Harbor Workers' Compensation Act, as amended (33 U.S.C. 941) and occupational safety and health standards issued by the Secretary pursuant to section 6 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 655).

§ 1915.2 Scope and application.

(a) Except where otherwise provided, the provisions of this part shall apply to all ship repairing, shipbuilding and shipbreaking employments and related employments.

(b) This part does not apply to matters under the control of the United States Coast Guard within the scope of Title 52 of the Revised Statutes and acts supplementary or amendatory thereto (46 U.S.C. secs. 1–1388 passim) including, but not restricted to, the master, ship's officer, crew members, design, construction and maintenance of the vessel, its gear and equipment; to matters within the regulatory authority of the United States Coast Guard to safeguard vessels, harbors, ports and waterfront facilities under the provisions of the Espionage Act of June 17, 1917, as amended (50 U.S.C. 191 et seq.; 22 U.S.C. 401 et seq.); including the provisions of Executive Order 10173, as amended by Executive Orders 10277 and 10352 (3 CFR, 1949–1953 Comp., pp. 356, 778 and 873); or to matters within the regulatory authority of the United States Coast Guard with respect to lights, warning devices, safety equipment and other matters relating to the promotion of safety of lives and property under section 4(e) of the Outer Continental Shelf Lands Act (43 U.S.C. 1333).

§ 1915.3 Responsibility.

(a) The responsibility for compliance with the regulations of this part is placed upon ''employers'' as defined in § 1915.4.

(b) This part does not apply to owners, operators, agents or masters of vessels unless such persons are acting as ''employers.'' However, this part is not intended to relieve owners, operators, agents or masters of vessels who are not ''employers'' from responsibilities or duties now placed upon them by law, regulation or custom.

(c) The responsibilities placed upon the competent person herein shall be deemed to be the responsibilities of the employer.

§ 1915.4 Definitions.

(a) The term SHALL indicates provisions which are mandatory.

(b) The term *Secretary* means the Secretary of Labor.

(c) The term *employer* means an employer, any of whose employees are employed, in whole or in part, in ship repairing, shipbuilding, shipbreaking or related employments as defined in this section on the navigable waters of the United States, including dry docks, graving docks and marine railways.

(d) The term *employee* means any person engaged in ship repairing, shipbuilding, shipbreaking or related employments on the navigable waters of the United States, including dry docks, graving docks and marine railways, other than the master, ship's officers, crew of the vessel, or any person engaged by the master to repair any vessel under 18 net tons.

(e) The term *gangway* means any ramp-like or stair-like means of access provided to enable personnel to board or leave a vessel including accommodation ladders, gangplanks and brows.

(f) The term *vessel* includes every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water, including special purpose floating structures not primarily designed for or used as a means of transportation on water.

(g) For purposes of § 1915.74, the term *barge* means an unpowered, flat bottom, shallow draft vessel including scows, carfloats and lighters. For purposes of this section, the term does not include ship shaped or deep draft barges.

(h) For purposes of § 1915.74, the term *river tow boat* means a shallow draft, low free board, self-propelled vessel designed to tow river barges by pushing ahead. For purposes of this section, the term does not include other towing vessels.

(i) The term *shipyard employment* means ship repairing, shipbuilding, shipbreaking and related employments.

(j) The terms *ship repair* and *ship repairing* mean any repair of a vessel including, but not restricted to, alterations, conversions, installations, cleaning, painting, and maintenance work.

(k) The term *shipbuilding* ns the construction of a vessel including the installation of machinery and equipment.

(l) The term *shipbreaking* means any breaking down of a vessel's structure for the purpose of scrapping the vessel, including the removal of gear, equipment or any component part of a vessel.

(m) The term *related employment* means any employment performed as an incident to or in conjunction with ship repairing, shipbuilding or shipbreaking work, including, but not restricted to, inspection, testing, and employment as a watchman.

(n) The term *hazardous substance* means a substance which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritant, or otherwise harmful is likely to cause injury.

(o) The term *competent person* for purposes of this part means a person who is capable of recognizing and evaluating employee exposure to hazardous substances or to other unsafe conditions and is capable of specifying the necessary protection and precautions to be taken to ensure the safety of employees as required by the particular regulation under the condition to which it applies. For the purposes of subparts B, C, and D of this part, except for § 1915.35(b)(8) and § 1915.36(a)(5), to which the above definition applies, the competent person must also meet the additional requirements of § 1915.7.

(p) The term *confined space* means a compartment of small size and limited access such as a double bottom tank, cofferdam, or other space which by its small size and confined nature can readily create or aggravate a hazardous exposure.

(q) The term *enclosed space* means any space, other than a confined space, which is enclosed by bulkheads and overhead. It includes cargo holds, tanks, quarters, and machinery and boiler spaces.

(r) The term *hot work* means riveting, welding, burning or other fire or spark producing operations.

(s) The term *cold work* means any work which does not involve riveting, welding, burning or other fire or spark producing operations.

(t) The term *portable unfired pressure vessel* means any pressure container or vessel used aboard ship, other than the ship's equipment, containing liquids or gases under pressure, excepting pressure vessels built to ICC regulations under 49 CFR part 178, subparts C and H.

(u) The term *powder actuated fastening tool* means a tool or machine which drives a stud, pin, or fastener by means of an explosive charge.

(v) For purposes of § 1915.97, the term *hazardous material* means a material

which has one or more of the following characteristics:

(1) Has a flash point below 140 °F., closed cup, or is subject to spontaneous heating;

(2) Has a threshold limit value below 500 p.p.m. in the case of a gas or vapor, below 500 mg./m.^{3} for fumes, and below 25 m.p.p.c.f. in case of a dust;

(3) Has a single dose oral LD_{50} below 500 mg./kg.;

(4) Is subject to polymerization with the release of large amounts of energy;

(5) Is a strong oxidizing or reducing agent;

(6) Causes first degree burns to skin in short time exposure, or is systemically toxic by skin contact; or

(7) In the course of normal operations, may produce dusts, gases, fumes, vapors, mists, or smokes which have one or more of the above characteristics.

§ 1915.5 Incorporation by reference.

(a) Specifications, standards, and codes of agencies of the U.S. Government, to the extent specified in the text, form a part of the regulations of this part. In addition, under the authority vested in the Secretary under the Act, the specifications, standards, and codes of organizations which are not agencies of the U.S. Government, in effect on the date of the promulgation of the regulations of this part as listed below, to the extent specified in the text, form a part of the regulations of this part.

(b) The materials listed in paragraph (d) of this section are incorporated by reference in the corresponding sections noted as they exist on the date of the approval, and a notice of any change in these materials will be published in the FEDERAL REGISTER. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51.

(c) Copies of the following standards that are issued by the respective private standards organizations may be obtained from the issuing organizations. The materials are available for purchase at the corresponding addresses of the private standards organizations noted below. In addition, all are available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington DC, and through the OSHA Docket Office, room N2625, U.S. Department of Labor, 200 Constitution Ave., NW, Washington, DC 20210, or any of its regional offices.

(d)(1) The following material is available for purchase from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

(i) ANSI A14.1–1959 Safety Code for Portable Wood Ladders, IBR approved for § 1915.72(a)(6)

(ii) ANSI A14.2–1956 Safety Code for Portable Metal Ladders, IBR approved for § 1995.72(a)(4)

(iii) ANSI B7.1–1964 Safety Code for the Use, Care, and Protection of Abrasive Wheels, IBR approval for § 1915.134(c)

(iv) ANSI Z87.1–1989 Practice for Occupational and Educational Eye and Face Protection, IBR approved for § 1915.153(b)(1).

(v) ANSI 87.1–1979 Practice for Occupational and Educational Eye and Face Protection, IBR approved for § 1915.153(b)(2)

(vi) ANSI Z89.1–1986 Personnel Protection—Protective Headgear for Industrial Workers Requirements, IBR approved for § 1915.155(b)(1)

(vii) ANSI Z89.1–1969 Safety Requirement for Industrial Head Protection, IBR approved for § 1915.155(b)(2).

(viii) ANSI Z41–1991 Personal Protection—Protective Footwear, IBR approved for § 1915.156(b)(1)

(ix) ANSI Z41–1983 Personal Protection—Protective Footwear, IBR approved for § 1915.156(b)(2).

(2) The following material is available for purchase from the American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017:

(i) ASME Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Unfired Pressure Vessels, 1963, IBR approved for § 1915.172(a).

(3) The following material is available for purchase from the American Conference of Governmental Industrial Hygienists (ACGIH), 1014 Broadway, Cincinnati, OH 45202:

(i) Threshold limit values, 1970, IBR approved for §§ 1915.12(b) and 1915.1000, table Z.

[61 FR 26359, May 24, 1996]

§ 1915.6 Commerical diving operations.

Commerical diving operations shall be subject to subpart T of part 1910, §§ 1910.401–1910.441 of this chapter.

§ 1915.7 Competent person.

(a) *Application*. This section applies to shipyard employment.

(b) *Designation*. (1) One or more competent persons shall be designated by the employer in accordance with the applicable requirements of this section, unless the requirements of subparts B, C, D and H of this part are always carried out by a Marine Chemist. *Exception:* The employer may designate any person who meets the applicable portions of the criteria set forth in paragraph (c) of this section as a competent person who is limited to performing testing to the following situations:

(i) Repair work on small craft in boat yards where only combustible gas indicator tests are required for fuel tank leaks or when using flammable paints below decks;

(ii) Building of wooden vessels where only knowledge of the precautions to be taken when using flammable paints is required;

(iii) The breaking of vessels where there is no fuel oil or other flammable hazard; and

(iv) Tests and inspections performed to comply with §§ 1915.35(b)(8) and 1915.36(a)(5).

(2)(i) The employer shall maintain either a roster of designated competent persons or a statement that a Marine Chemist will perform the tests or inspections which require a competent person.

(ii) The employer shall make the roster of designated persons or the statement available to employees, the employee's representative, the Director or the Assistant Secretary upon request.

(iii) The roster shall contain, as a minimum, the following:

(A) The employers' name,

(B) The designated competent person's name(s), and

(C) The date the employee was trained as a competent person.

(c) *Criteria*. The employer shall ensure that each designated competent person has the following skills and knowledge:

(1) Ability to understand and carry out written or oral information or instructions left by Marine Chemist, Coast Guard authorized persons and Certified Industrial Hygienists;

(2) Knowledge of subparts B, C, D and H of this part;

(3) Knowledge of the structure, location, and designation of spaces where work is done;

(4) Ability to calibrate and use testing equipment including but not limited to, oxygen indicators, combustible gas indicators, carbon monoxide indicators, and carbon dioxide indicators, and to interpret accurately the test results of that equipment;

(5) Ability to perform all required tests and inspections which are or may be performed by a competent person as set forth in subparts B, C, D and H of this part.

(6) Ability to inspect, test, and evaluate spaces to determine the need for further testing by a Marine Chemist or a Certified Industrial Hygienist; and

(7) Ability to maintain records required by this section.

(d) *Recordkeeping*. (1) When tests and inspections are performed by a competent person, Marine Chemist, or Certified Industrial Hygienist as required by any provisions of subparts B, C, D, or H of this part, the employer shall ensure that the person performing the test and inspection records the location, time, date, location of inspected spaces, and the operations performed, as well as the test results and any instructions.

(2) The employer shall ensure that the records are posted in the immediate vicinity of the affected operations while work in the spaces is in progress. The records shall be kept on file for a period of at least three months from the completion date of the specific job for which they were generated.

(3) The employer shall ensure that the records are available for inspection by the Assistant Secretary, Director, and employees and their representatives.

[59 FR 37856, July 25, 1994]

§ 1915.8. OMB control numbers under the Paperwork Reduction Act.

The following sections or paragraphs contain a collection of information requirement which has been approved by the Office of Management and Budget under the control number listed.

29 CFR citation	OMB control No.
1915.11—1915.16	1218–0011
1915.113	1218–0220
1915.152(b)	1218–0215
1915.152(e)	1218–0215
1915.159(d)	1218–0215
1915.160(d)	1218–0215
1915.172	1218–0220
1915.1001	1218–0195
1915.1003	1218–0085
1915.1004	1218–0084
1915.1006	1218–0086
1915.1007	1218–0083
1915.1008	1218–0087
1915.1009	1218–0089
1915.1010	1218–0082
1915.1011	1218–0090
1915.1012	1218–0080
1915.1013	1218–0079
1915.1014	1218–0088
1915.1015	1218–0044
1915.1016	1218–0081
1915.1017	1218–0010
1915.1018	1218–0104
1915.1025	1218–0092
1915.1027	1218–0185
1915.1028	1218–0129
1915.1030	1218–0180
1915.1044	1218–0101
1915.1045	1218–0126
1915.1047	1218–0108
1915.1048	1218–0145
1915.1050	1218–0184
1915.1120	1218–0065
1915.1200	1218–0072
1915.1450	1218–0131

[61 FR 5509, Feb. 13, 1996, as amended at 62 FR 33547, June 20, 1997; 63 FR 13340, Mar. 19, 1998]

Subpart B—Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment

SOURCE: 59 FR 37857, July 25, 1994, unless otherwise noted.

§ 1915.11 Scope, application and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to work in confined and enclosed spaces and other dangerous atmospheres in shipyard employment, including vessels, vessel sections, and on land-side operations regardless of geographic location.

(b) *Definitions applicable to this subpart.*

Adjacent spaces means those spaces bordering a subject space in all directions, including all points of contact, corners, diagonals, decks, tank tops, and bulkheads.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, or designated representative.

Certified Industrial Hygienist (CIH) means an industrial hygienist who is certified by the American Board of Industrial Hygiene.

Coast Guard authorized person means an individual who meets the requirement of appendix B to subpart B of this part 1915 for tank vessels, for passenger vessels, and for cargo and miscellaneous vessels.

Dangerous atmosphere means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (i.e., escape unaided from a confined or enclosed space), injury, or acute illness.

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

Enter with Restrictions denotes a space where entry for work is permitted only if engineering controls, personal protective equipment, clothing, and time limitations are as specified by the Marine Chemist, Certified Industrial Hygienist, or the shipyard competent person.

Entry means the action by which a person passes through an opening into a space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Hot work means any activity involving riveting, welding, burning, the use of powder-actuated tools or similar fire-producing operations. Grinding, drilling, abrasive blasting, or similar spark-producing operations are also considered hot work except when such operations are isolated physically from any atmosphere containing more than

10 percent of the lower explosive limit of a flammable or combustible substance.

Immediately dangerous to life or health (IDLH) means an atmosphere that poses an immediate threat to life or that is likely to result in acute or immediate severe health effects.

Inert or inerted atmosphere means an atmospheric condition where:

(1) The oxygen content of the atmosphere in the space is maintained at a level equal to or less than 8.0 percent by volume or at a level at or below 50 percent of the amount required to support combustion, whichever is less; or

(2) The space is flooded with water and the vapor concentration of flammable or combustible materials in the free space atmosphere above the water line is less than 10 percent of the lower explosive limit for the flammable or combustible material.

Labeled means identified with a sign, placard, or other form of written communication, including pictograms, that provides information on the status or condition of the work space to which it is attached.

Lower explosive limit (LEL) means the minimum concentration of vapor in air below which propagation of a flame does not occur in the presence of an ignition source.

Marine Chemist means an individual who possesses a current Marine Chemist Certificate issued by the National Fire Protection Association.

Not Safe for Hot Work denotes a space where hot work may not be performed because the conditions do not meet the criteria for Safe for Hot Work.

Nationally Recognized Testing Laboratory (NRTL) means an organization recognized by OSHA, in accordance with appendix A of 29 CFR 1910.7, which tests for safety and lists or labels or accepts equipment and materials that meet all the criteria found in § 1910.7(b)(1) through (b)(4)(ii).

Not Safe for Workers denotes a space where an employee may not enter because the conditions do not meet the criteria for Safe for Workers.

Oxygen-deficient atmosphere means an atmosphere having an oxygen concentration of less than 19.5 percent by volume.

Oxygen-enriched atmosphere means an atmosphere that contains 22.0 percent or more oxygen by volume.

Safe for Hot Work denotes a space that meets all of the following criteria:

(1) The oxygen content of the atmosphere does not exceed 22.0 percent by volume;

(2) The concentration of flammable vapors in the atmosphere is less than 10 percent of the lower explosive limit;

(3) The residues or materials in the space are not capable of producing a higher concentration than permitted in paragraph (1) or (2) of the above, under existing atmospheric conditions in the presence of hot work and while maintained as directed by the Marine Chemist or competent person, and

(4) All adjacent spaces have been cleaned, or inerted, or treated sufficiently to prevent the spread of fire.

Safe for Workers denotes a space that meets the following criteria:

(1) The oxygen content of the atmosphere is at least 19.5 percent and below 22 percent by volume;

(2) The concentration of flammable vapors is below 10 percent of the lower explosive limit (LEL);

(3) Any toxic materials in the atmosphere associated with cargo, fuel, tank coatings, or inerting media are within permissible concentrations at the time of the inspection; and

(4) Any residues or materials associated with the work authorized by the Marine Chemist, Certified Industrial Hygienist, or competent person will not produce uncontrolled release of toxic materials under existing atmospheric conditions while maintained as directed.

Space means an area on a vessel or vessel section or within a shipyard such as, but not limited to: cargo tanks or holds; pump or engine rooms; storage lockers; tanks containing flammable or combustible liquids, gases, or solids; rooms within buildings; crawl spaces; tunnels; or accessways. The atmosphere within a space is the entire area within its bounds.

Upper explosive limit (UEL) means the maximum concentration of flammable vapor in air above which propagation of flame does not occur on contact with a source of ignition.

Vessel section means a sub-assembly, module, or other component of a vessel being built, repaired, or broken.

Visual inspection means the physical survey of the space, its surroundings and contents to identify hazards such as, but not limited to, restricted accessibility, residues, unguarded machinery, and piping or electrical systems.

§ 1915.12 Precautions and the order of testing before entering confined and enclosed spaces and other dangerous atmospheres.

The employer shall ensure that atmosphereic testing is performed in the following sequence: oxygen content, flammability, toxicity.

(a) *Oxygen content.* (1) The employer shall ensure that the following spaces are visually inspected and tested by a competent person to determine the atmosphere's oxygen content prior to initial entry into the space by an employee:

(i) Spaces that have been sealed, such as, but not limited to, spaces that have been coated and closed up, and nonventilated spaces that have been freshly painted;

(ii) Spaces and adjacent spaces that contain or have contained combustible or flammable liquids or gases;

(iii) Spaces and adjacent spaces that contain or have contained liquids, gases, or solids that are toxic, corrosive, or irritant;

(iv) Spaces and adjacent spaces that have been fumigated; and

(v) Spaces containing materials or residues of materials that create an oxygen-deficient atmosphere.

(2) If the space to be entered contains an oxygen deficient atmosphere, the space shall be labeled ''Not Safe for Workers'' or, if oxygen-enriched, ''Not Safe for Workers—Not Safe for Hot Work.'' If an oxygen-deficient or oxygen-enriched atmosphere is found, ventilation shall be provided at volumes and flow rates sufficient to ensure that the oxygen content is maintained at or above 19.5 percent and below 22.0 percent by volume. The warning label may be removed when the oxygen content is equal to or greater than 19.5 and less than 22.0 percent by volume.

(3) An employee may not enter a space where the oxygen content, by volume, is below 19.5 percent or above 22.0 percent. Exception: An employee may enter for emergency rescue or for a short duration for installation of ventilation equipment necessary to start work in the space provided:

(i) The atmosphere in the space is monitored for oxygen content, by volume, continuously; and

(ii) Respiratory protection and other appropriate personal protective equipment and clothing are provided in accordance with subpart I of this part.

NOTE TO PARAGRAPH (a): Other provisions for work in IDLH atmospheres are located in subpart I of this part.

(b) *Flammable atmospheres.* (1) The employer shall ensure that spaces and adjacent spaces that contain or have contained combustible or flammable liquids or gases are:

(i) Inspected visually by the competent person to determine the presence of combustible or flammable liquids; and

(ii) Tested by a competent person prior to entry by an employee to determine the concentration of flammable vapors and gases within the space.

(2) If the concentration of flammable vapors or gases in the space to be entered is equal to or greater than 10 percent of the lower explosive limit, the space shall be labeled ''Not Safe for Workers'' and ''Not Safe for Hot Work.'' Ventilation shall be provided at volumes and flow rates sufficient to ensure that the concentration of flammable vapors is maintained below 10 percent of the lower explosive limit. The warning labels may be removed when the concentration of flammable vapors is below 10 percent of the lower explosive limit.

(3) An employee may not enter a space where the concentration of flammable vapors or gases is equal to or greater than 10 percent of the lower explosive limit. Exception: An employee may enter for emergency rescue or for a short duration for installation of ventilation equipment necessary to start work in the space, provided:

(i) No ignition sources are present;

(ii) The atmosphere in the space is monitored continuously;

(iii) Atmospheres at or above the upper explosive limit are maintained; and

(iv) Respiratory protection and other appropriate personal protective equipment and clothing are provided in accordance with subpart I of this part.

NOTE 1 TO PARAGRAPH (b): Additional provisions for work in IDLH atmospheres are located in subpart I of this part.

NOTE 2 TO PARAGRAPH (b): Additional provisions for work in spaces containing a flammable substance which also has a permissible exposure limit, are located in subpart Z of 29 CFR part 1915, and § 1915.12(c).

(c) *Toxic, corrosive, irritant or fumigated atmospheres and residues.* (1) The employer shall ensure that spaces or adjacent spaces that contain or have contained liquids, gases, or solids that are toxic, corrosive or irritant are:

(i) Inspected visually by the competent person to determine the presence of toxic, corrosive, or irritant residue contaminants; and

(ii) Tested by a competent person prior to initial entry by an employee to determine the air concentration of toxics, corrosives, or irritants within the space.

(2) If a space contains an air concentration of a material which exceeds a part 1915 subpart Z permissible exposure limit (PEL) or is IDLH, the space shall be labeled ''Not Safe for Workers.'' Ventilation shall be provided at volumes and flow rates which will ensure that air concentrations are maintained within the PEL or, in the case of contaminants for which there is no established PEL, below the IDLH. The warning label may be removed when the concentration of contaminants is maintained within the PEL or below IDLH level.

(3) If a space cannot be ventilated to within the PELs or is IDLH, a Marine Chemist or CIH must re-test until the space can be certified ''Enter with Restrictions'' or ''Safe for Workers.''

(4) An employee may not enter a space whose atmosphere exceeds a PEL or is IDLH. Exception: An employee may enter for emergency rescue, or for a short duration for installation of ventilation equipment provided:

(i) The atmosphere in the space is monitored continuously;

(ii) Respiratory protection and other necessary and appropriate personal protective equipment and clothing are provided in accordance with subpart I of this part.

NOTE TO PARAGRAPH (c): Other provisions for work in IDLH atmospheres are located in subpart I of this part.

(d) *Training of employees entering confined and enclosed spaces or other dangerous atmospheres.* (1) The employer shall ensure that each employee that enters a confined or enclosed space and other areas with dangerous atmospheres is trained to perform all required duties safely.

(2) The employer shall ensure that each employee who enters a confined space, enclosed space, or other areas with dangerous atmospheres is trained to:

(i) Recognize the characteristics of the confined space;

(ii) Anticipate and be aware of the hazards that may be faced during entry;

(iii) Recognize the adverse health effects that may be caused by the exposure to a hazard;

(iv) Understand the physical signs and reactions related to exposures to such hazards;

(v) Know what personal protective equipment is needed for safe entry into and exit from the space;

(vi) Use personal protective equipment; and

(vii) Where necessary, be aware of the presence and proper use of barriers that may be needed to protect an entrant from hazards.

(3) The employer shall ensure that each entrant into confined or enclosed spaces or other dangerous atmospheres is trained to exit the space or dangerous atmosphere whenever:

(i) The employer or his or her representative orders evacuation;

(ii) An evacuation signal such as an alarm is activated ; or

(iii) The entrant perceives that he or she is in danger.

(4) The employer shall provide each employee with training:

(i) Before the entrant begins work addressed by this section; and

(ii) Whenever there is a change in operations or in an employee's duties that presents a hazard about which the employee has not previously been trained.

(5) The employer shall certify that the training required by paragraphs (d)(1) through (d)(4) of this section has been accomplished.

(i) The certification shall contain the employee's name, the name of the certifier, and the date(s) of the certification.

(ii) The certification shall be available for inspection by the Assistant Secretary, the Director, employees, and their representatives.

(e) *Rescue teams.* The employer shall either establish a shipyard rescue team or arrange for an outside rescue team which will respond promptly to a request for rescue service.

(1) Shipyard rescue teams shall meet the following criteria:

(i) Each employee assigned to the shipyard team shall be provided with and trained to use the personal protective equipment he or she will need, including respirators and any rescue equipment necessary for making rescues from confined and enclosed spaces and other dangerous atmospheres.

(ii) Each employee assigned to the shipyard rescue team shall be trained to perform his or her rescue functions including confined and enclosed and other dangerous atmosphere entry.

(iii) Shipyard rescue teams shall practice their skills at least once every 12 months. Practice drills shall include the use of mannequins and rescue equipment during simulated rescue operations involving physical facilities that approximate closely those facilities from which rescue may be needed.

NOTE TO PARAGRAPH (e)(1)(iii): If the team performs an actual rescue during the 12 month period, an additional practice drill for that type of rescue is not required.

(iv) At least one person on each rescue team shall maintain current certification in basic first aid which includes maintenance of an airway, control of bleeding, maintenance of circulation and cardiopulmonary resuscitation (CPR) skills.

(2) The employer shall inform outside rescue teams of the hazards that the team may encounter when called to perform confined and enclosed space or other dangerous atmosphere rescue at the employer's facility so that the rescue team can be trained and equipped.

NOTE TO PARAGRAPH (e): The criteria for in-house rescue, listed in paragraph (e)(1) can be used by the employer in evaluating outside rescue services.

(f) *Exchanging hazard information between employers.* Each employer whose employees work in confined and enclosed spaces or other dangerous atmospheres shall ensure that all available information on the hazards, safety rules, and emergency procedures concerning those spaces and atmospheres is exchanged with any other employer whose employees may enter the same spaces.

[59 FR 37857, July 25, 1994, as amended at 60 FR 14219, Mar. 16, 1995]

§ 1915.13 Cleaning and other cold work.

(a) *Locations covered by this section.* The employer shall ensure that manual cleaning and other cold work are not performed in the following spaces unless the conditions of paragraph (b) of this section have been met:

(1) Spaces containing or having last contained bulk quantities of combustible or flammable liquids or gases; and

(2) Spaces containing or having last contained bulk quantities of liquids, gases or solids that are toxic, corrosive or irritating.

(b) *Requirements for performing cleaning or cold work.* (1) Liquid residues of hazardous materials shall be removed from work spaces as thoroughly as practicable before employees start cleaning operations or cold work in a space. Special care shall be taken to prevent the spilling or the draining of these materials into the water surrounding the vessel, or for shore-side operations, onto the surrounding work area.

(2) Testing shall be conducted by a competent person to determine the concentration of flammable, combustible, toxic, corrosive, or irritant vapors within the space prior to the beginning of cleaning or cold work.

(3) Continuous ventilation shall be provided at volumes and flow rates sufficient to ensure that the concentration(s) of:

(i) Flammable vapor is maintained below 10 percent of the lower explosive limit; and

NOTE TO PARAGRAPH (b)(3)(i): Spaces containing highly volatile residues may require additional ventilation to keep the concentration of flammable vapors below 10 percent of the lower explosive limit and within the permissible exposure limit.

(ii) Toxic, corrosive, or irritant vapors are maintained within the permissible exposure limits and below IDLH levels.

(4) Testing shall be conducted by the competent person as often as necessary during cleaning or cold work to assure that air concentrations are below 10 percent of the lower explosive limit and within the PELs and below IDLH levels. Factors such as, but not limited to, temperature, volatility of the residues and other existing conditions in and about the spaces are to be considered in determining the frequency of testing necessary to assure a safe atmosphere.

NOTE TO PARAGRAPH (b)(4): See appendix A for additional information on frequency of testing.

(5) Spills or other releases of flammable, combustible, toxic, corrosive, and irritant materials shall be cleaned up as work progresses.

(6) An employee may not enter a confined or enclosed space or other dangerous atmosphere if the concentration of flammable or combustible vapors in work spaces exceeds 10 percent of the lower explosive limit. Exception: An employee may enter for emergency rescue or for a short duration for installation of ventilation equipment provided:

(i) No ignition sources are present;

(ii) The atmosphere in the space is monitored continuously;

(iii) The atmosphere in the space is maintained above the upper explosive limit; and

(iv) Respiratory protection, personal protective equipment, and clothing are provided in accordance with subpart I of this part.

NOTE TO PARAGRAPH (b)(6): Other provisions for work in IDLH and other dangerous atmospheres are located in subpart I of this part.

(7) A competent person shall test ventilation discharge areas and other areas where discharged vapors may collect to determine if vapors discharged from the spaces being ventilated are accumulating in concentrations hazardous to employees.

(8) If the tests required in paragraph (b)(7) of this section indicate that concentrations of exhaust vapors that are hazardous to employees are accumulating, all work in the contaminated area shall be stopped until the vapors have dissipated or been removed.

(9) Only explosion-proof, self-contained portable lamps, or other electric equipment approved by a National Recognized Testing Laboratory (NRTL) for the hazardous location shall be used in spaces described in paragraph (a) of this section until such spaces have been certified as ''Safe for Workers.''

NOTE TO PARAGRAPH (b)(9): Battery-fed, portable lamps or other electric equipment bearing the approval of a NRTL for the class, and division of the location in which they are used are deemed to meet the requirements of this paragraph.

(10) The employer shall prominently post signs that prohibit sources of ignition within or near a space that has contained flammable or combustible liquids or gases in bulk quantities:

(i) At the entrance to those spaces;

(ii) In adjacent spaces; and

(iii) In the open area adjacent to those spaces.

(11) All air moving equipment and its component parts, including duct work, capable of generating a static electric discharge of sufficient energy to create a source of ignition, shall be bonded electrically to the structure of a vessel or vessel section or, in the case of landside spaces, grounded to prevent an electric discharge in the space.

(12) Fans shall have non-sparking blades, and portable air ducts shall be of non-sparking materials.

NOTE TO PARAGRAPH (b): See § 1915.12(c) of this part and applicable requirements of 29 CFR part 1915, subpart Z for other provisions affecting cleaning and cold work.

§ 1915.14 Hot work.

(a) *Hot work requiring testing by a Marine Chemist or Coast Guard authorized person.* (1) The employer shall ensure that hot work is not performed in or on any of the following confined and enclosed spaces and other dangerous atmospheres, boundaries of spaces or pipelines until the work area has been

tested and certified by a Marine Chemist or a U.S. Coast Guard authorized person as ''Safe for Hot Work'':

(i) Within, on, or immediately adjacent to spaces that contain or have contained combustible or flammable liquids or gases.

(ii) Within, on, or immediately adjacent to fuel tanks that contain or have last contained fuel; and

(iii) On pipelines, heating coils, pump fittings or other accessories connected to spaces that contain or have last contained fuel.

(iv) Exception: On dry cargo, miscellaneous and passenger vessels and in the landside operations within spaces which meet the standards for oxygen, flammability and toxicity in § 1915.12, but are adjacent to spaces containing flammable gases or liquids, as long as the gases or liquids have a flash point below 150 °F (65.6 °C) and the distance between such spaces and the work is 25 feet (7.5m) or greater.''

NOTE: For flammable liquids with flash points above 150 °F (65.6 °C), see paragraph (b) of this section.

NOTE TO PARAGRAPH (a)(1): The criteria for safe for hot work is located in the definition section of subpart B.

(2) The certificate issued by the Marine Chemist or Coast Guard authorized person shall be posted in the immediate vicinity of the affected operations while they are in progress and kept on file for a period of at least three months from the date of the completion of the operation for which the certificate was generated.

(b) *Hot work requiring testing by a competent person.* (1) Hot work is not permitted in or on the following spaces or adjacent spaces or other dangerous atmospheres until they have been tested by a competent person and determined to contain no concentrations of flammable vapors equal to or greater than 10 percent of the lower explosive limit:

(i) Dry cargo holds,

(ii) The bilges,

(iii) The engine room and boiler spaces for which a Marine Chemist or a Coast Guard authorized person certificate is not required under paragraph (a)(1)(i) of this section, and

(iv) Vessels and vessel sections for which a Marine Chemist or Coast Guard authorized person certificate is not required under paragraph (a)(1)(i) of this section, and

(v) Land-side confined and enclosed spaces or other dangerous atmospheres not covered by paragraph (a)(1) of this section.

(2) If the concentration of flammable vapors or gases is equal to or greater than 10 percent of the lower explosive limit in the space or an adjacent space where the hot work is to be done, then the space shall be labeled ''Not Safe for Hot Work'' and ventilation shall be provided at volumes and flow rates sufficient to ensure that the concentration of flammable vapors or gases is below 10 percent by volume of the lower explosive limit. The warning label may be removed when the concentration of flammable vapors and gases are below 10 percent lower explosive limit.

NOTE TO § 1915.14: See appendix A for additional information relevant to performing hot work safely.

[59 FR 37857, July 25, 1994, as amended at 60 FR 14219, Mar. 16, 1995]

§ 1915.15 Maintenance of safe conditions.

(a) *Preventing hazardous materials from entering.* Pipelines that could carry hazardous materials into spaces that have been certified ''Safe for Workers'' or ''Safe for Hot Work'' shall be disconnected, blanked off, or otherwise blocked by a positive method to prevent hazardous materials from being discharged into the space.

(b) *Alteration of existing conditions.* When a change that could alter conditions within a tested confined or enclosed space or other dangerous atmosphere occurs, work in the affected space or area shall be stopped. Work may not be resumed until the affected space or area is visually inspected and retested and found to comply with §§ 1915.12, 1915.13, and 1915.14 of this part, as applicable.

NOTE TO PARAGRAPH (b): Examples of changes that would warrant the stoppage of work include: The opening of manholes or other closures or the adjusting of a valve regulating the flow of hazardous materials.

(c) *Tests to maintain the conditions of a Marine Chemist's or Coast Guard authorized person's certificates.* A competent

person shall visually inspect and test each space certified as ''Safe for Workers'' or ''Safe for Hot Work,'' as often as necessary to ensure that atmospheric conditions within that space is maintained within the conditions established by the certificate after the certificate has been issued.

(d) *Change in the conditions of a Marine Chemist's or Coast Guard authorized person's certificate.* If a competent person finds that the atmospheric conditions within a certified space fail to meet the applicable requirements of §§ 1915.12, 1915.13, and 1915.14 of this part, work in the certified space shall be stopped and may not be resumed until the space has been retested by a Marine Chemist or Coast Guard authorized person and a new certificate issued in accordance with § 1915.14(a).

(e) Tests to maintain a competent person's findings. After a competent person has conducted a visual inspection and tests required in §§ 1915.12, 1915.13, and 1915.14 of this part and determined a space to be safe for an employee to enter, he or she shall continue to test and visually inspect spaces as often as necessary to ensure that the required atmospheric conditions within the tested space are maintained.''

(f) *Changes in conditions determined by competent person's findings.* After the competent person has determined initially that a space is safe for an employee to enter and he or she finds subsequently that the conditions within the tested space fail to meet the requirements of §§ 1915.12, 1915.13, and 1915.14, of this part, as applicable, work shall be stopped until the conditions in the tested space are corrected to comply with §§ 1915.12, 1915.13, and 1915.14, as applicable.

[59 FR 37857, July 25, 1994, as amended at 60 FR 14219, Mar. 16, 1995]

§ 1915.16 Warning signs and labels.

(a) *Employee comprehension of signs and labels.* The Employer shall ensure that each sign or label posted to comply with the requirements of this subpart is presented in a manner that can be perceived and understood by all employees.

(b) *Posting of large work areas.* A warning sign or label required by paragraph (a) of this section need not be posted at an individual tank, compartment or work space within a work area if the entire work area has been tested and certified: not safe for workers, not safe for hot work, and if the sign or label to this effect is posted conspicuously at each means of access to the work area.

APPENDIX A TO SUBPART B OF PART 1915—COMPLIANCE ASSISTANCE GUIDELINES FOR CONFINED AND ENCLOSED SPACES AND OTHER DANGEROUS ATMOSPHERES

This appendix is a non-mandatory set of guidelines provided to assist employers in complying with the requirements of this subpart. This appendix neither creates additional obligations nor detracts from obligations otherwise contained in the standard. It is intended to provide explanatory information and educational material to employers and employees to foster understanding of, and compliance with, the standard.

Sections 1915.11 through 1915.16. These standards are minimum safety standards for entering and working safely in vessel tanks and compartments.

Section 1915.11(b) Definition of ''Hot work.'' There are several instances in which circumstances do not necessitate that grinding, drilling, abrasive blasting be regarded as hot work. Some examples are:

1. Abrasive blasting of the hull for paint preparation does not necessitate pumping and cleaning the tanks of a vessel.

2. Prior to hot work on any hollow structure, the void space should be tested and appropriate precautions taken.

Section 1915.11(b) Definition of ''Lower explosive limit.'' The terms lower flammable limit (LFL) and lower explosive limit (LEL) are used interchangeably in fire science literature.

Section 1915.11(b) Definition of ''Upper explosive limit.'' The terms upper flammable limit (UFL) and upper explosive limit (UEL) are used interchangeably in fire science literature.

Section 1915.12(a)(4). After a tank has been properly washed and ventilated, the tank should contain 20.8 percent oxygen by volume. This is the same amount found in our normal atmosphere at sea level. However, it is possible that the oxygen content will be lower. When this is the case, the reasons for this deficiency should be determined and corrective action taken.

An oxygen content of 19.5 percent can support life and is adequate for entry. However, any oxygen level less than 20.8 percent and greater than 19.5 percent level should also alert the competent person to look for the

causes of the oxygen deficiency and to correct them prior to entry.

Section 1915.12(b)(4) Flammable atmospheres. Atmospheres with a concentration of flammable vapors at or above 10 percent of the lower explosive limit (LEL) are considered hazardous when located in confined spaces. However, atmospheres with flammable vapors below 10 percent of the LEL are not necessarily safe.

Such atmospheres are too lean to burn. Nevertheless, when a space contains or produces measurable flammable vapors below the 10 percent LEL, it might indicate that flammable vapors are being released or introduced into the space and could present a hazard in time. Therefore, the cause of the vapors should be investigated and, if possible, eliminated prior to entry.

Some situations that have produced measurable concentrations of flammable vapors that could exceed 10 percent of the LEL in time are:

1. Pipelines that should have been blanked or disconnected have opened, allowing product into the space.

2. The vessel may have shifted, allowing product not previously cleaned and removed during washing to move into other areas of the vessel.

3. Residues may be producing the atmosphere by releasing flammable vapor.

Section 1915.12(b)(6) Flammable atmospheres that are toxic. An atmosphere with a measurable concentration of a flammable substance below 10 percent of the LEL may be above the OSHA permissible exposure limit for that substance. In that case, refer to §1915.12(c) (2), (3), and (4).

Sections 1915.13(b)(4), 1915.15(c), and 1915.15(e). The frequency with which a tank is monitored to determine if atmospheric conditions are being maintained is a function of several factors that are discussed below:

1. *Temperature.* Higher temperatures will cause a combustible or flammable liquid to vaporize at a faster rate than lower temperatures. This is important since hotter days may cause tank residues to produce more vapors and that may result in the vapors exceeding 10 percent of the LEL or an overexposure to toxic contaminants.

2. *Work in the tank.* Any activity in the tank could change the atmospheric conditions in that tank. Oxygen from a leaking oxyfuel hose or torch could result in an oxygen-enriched atmosphere that would more easily propagate a flame. Some welding operations use inert gas, and leaks can result in an oxygen-deficient atmosphere. Manual tank cleaning with high pressure spray devices can stir up residues and result in exposures to toxic contaminants. Simple cleaning or mucking out, where employees walk through and shovel residues and sludge, can create a change in atmospheric conditions.

3. *Period of time elapsed.* If a period of time has elapsed since a Marine Chemist or Coast Guard authorized person has certified a tank as safe, the atmospheric condition should be rechecked by the competent person prior to entry and starting work.

4. *Unattended tanks or spaces.* When a tank or space has been tested and declared safe, then subsequently left unattended for a period of time, it should be retested prior to entry and starting work. For example, when barges are left unattended at night, unidentified products from another barge are sometimes dumped into their empty tanks. Since this would result in a changed atmosphere, the tanks should be retested prior to entry and starting work.

5. *Work break.* When workers take a break or leave at the end of the shift, equipment sometimes is inadvertently left in the tanks. At lunch or work breaks and at the end of the shift are the times when it is most likely someone will leave a burning or cutting torch in the tank, perhaps turned on and leaking oxygen or an inert gas. Since the former can produce an oxygen-enriched atmosphere, and the latter an oxygen-deficient atmosphere, tanks should be checked for equipment left behind, and atmosphere, monitored if necessary prior to re-entering and resuming work. In an oxygen-enriched atmosphere, the flammable range is severely broadened. This means that an oxygen-enriched atmosphere can promote very rapid burning.

6. *Ballasting or trimming.* Changing the position of the ballast, or trimming or in any way moving the vessel so as to expose cargo that had been previously trapped, can produce a change in the atmosphere of the tank. The atmosphere should be retested after any such move and prior to entry or work.

Section 1915.14 (a) and (b) Hot work. This is a reminder that other sections of the OSHA shipyard safety and health standards in part 1915 should be reviewed prior to starting any hot work. Most notably, subpart D, Welding, Cutting and Heating, places additional restrictions on hot work: The requirements of §§1915.51 and 1915.53 must be met before hot work is begun on any metal that is toxic or is covered by a preservative coating respectively; the requirements of §1915.54 must be met before welding, cutting, or heating is begun on any structural voids.

Section 1915.12(a)(2). During hot work, more than 20.8 percent oxygen by volume can be unsafe since it extends the normal flammable range. The standard permits the oxygen level to reach 22 percent by volume in order to account for instrument error. However, the cause of excess oxygen should be investigated and the source removed.

Section 1915.16(b). If the entire vessel has been found to be in the same condition, then

employers shall be considered to be in compliance with this requirement when signs using appropriate warning language in accordance with §1915.16(a) are posted at the gangway and at all other means of access to the vessel.

APPENDIX B TO SUBPART B OF PART 1915—REPRINT OF U.S. COAST GUARD REGULATIONS REFERENCED IN SUBPART B, FOR DETERMINATION OF COAST GUARD AUTHORIZED PERSONS

This appendix provides a complete reprint of U.S. Coast Guard regulations as of October 1, 1993, referenced in subpart B for purposes of determining who is a Coast Guard authorized person.

1. Title 46 CFR 35.01–1 (a) through (c) covering hot work on tank vessels reads as follows:

(a) The provisions of ''Standard for the Control of Gas Hazards on Vessels to be Repaired,'' NFPA No. 306, published by National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, shall be used as a guide in conducting the inspections and issuance of certificates required by this section.

(b) Until an inspection has been made to determine that such operation can be undertaken with safety, no alterations, repairs, or other such operations involving riveting, welding, burning, or like fire-producing actions shall be made:

(1) Within or on the boundaries of cargo tanks that have been used to carry flammable or combustible liquid or chemicals in bulk, or within spaces adjacent to such cargo tanks; or

(2) Within or on the boundaries of fuel tanks; or

(3) To pipe lines, heating coils, pumps, fittings, or other appurtenances connected to such cargo or fuel tanks.

(c) Such inspections shall be made and evidenced as follows:

(1) In ports or places in the United States or its territories and possessions, the inspection shall be made by a Marine Chemist certificated by the National Fire Protection Association; however, if the services of such certified Marine Chemists are not reasonably available, the Officer in Charge, Marine Inspection, upon the recommendation of the vessel owner and his contractor or their representative, shall select a person who, in the case of an individual vessel, shall be authorized to make such inspection. If the inspection indicates that such operations can be undertaken with safety, a certificate setting forth the fact in writing and qualified as may be required, shall be issued by the certified Marine Chemist or the authorized person before the work is started. Such qualifications shall include any requirements as may be deemed necessary to maintain, insofar as can reasonably be done, the safe conditions in the spaces certified, throughout the operation and shall include such additional tests and certifications as considered required. Such qualifications and requirements shall include precautions necessary to eliminate or minimize hazards that may be present from protective coatings or residues from cargoes.

2. Title 46 CFR 71.60(c)(1) covering hot work on passenger vessels reads as follows:

(a) The provisions of ''Standard for the Control of Gas Hazards on Vessels to be Repaired,'' NFPA No. 306, published by National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, shall be used as a guide in conducting the inspections and issuance of certificates required by this section.

(b) Until an inspection has been made to determine that such operation can be undertaken with safety, no alterations, repairs, or other such operations involving riveting, welding, burning, or like fire-producing actions shall be made:

(1) Within or on the boundaries of cargo tanks which have been used to carry flammable or combustible liquid or chemicals in bulk, or within spaces adjacent to such cargo tanks; or

(2) Within or on the boundaries of fuel tanks; or

(3) To pipe lines, heating coils, pumps, fittings, or other appurtenances connected to such cargo or fuel tanks.

(c) Such inspections shall be made and evidenced as follows:

(1) In ports or places in the United States or its territories and possessions the inspection shall be made by a Marine Chemist certificated by the National Fire Protection Association; however, if the services of such certified Marine Chemist are not reasonably available, the Officer in Charge, Marine Inspection, upon the recommendation of the vessel owner and his contractor or their representative, shall select a person who, in the case of an individual vessel, shall be authorized to make such inspection. If the inspection indicated that such operations can be undertaken with safety, a certificate setting forth the fact in writing and qualified as may be required, shall be issued by the certified Marine Chemist or the authorized person before the work is started. Such qualifications shall include any requirements as may be deemed necessary to maintain, insofar as can reasonably be done, the safe conditions in the spaces certified throughout the operation and shall include such additional tests and certifications as considered required. Such qualifications and requirements shall include precautions necessary to eliminate or minimize hazards that may be present from protective coatings or residues from cargoes.

3. Title 46 CFR 91.50–1(c)(1) covering hot work on cargo and miscellaneous vessels as follows:

(a) The provisions of ''Standard for the Control of Gas Hazards on Vessels to be Repaired,'' NFPA No. 306, published by National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, shall be used as a guide in conducting the inspections and issuance of certificates required by this section.

(b) Until an inspection has been made to determine that such operation can be undertaken with safety, no alterations, repairs, or other such operations involving riveting, welding, burning, or like fire-producing actions shall be made:

(1) Within or on the boundaries of cargo tanks which have been used to carry flammable or combustible liquid or chemicals in bulk, or within spaces adjacent to such cargo tanks; or,

(2) Within or on the boundaries of fuel tanks; or,

(3) To pipe lines, heating coils, pumps, fittings, or other appurtenances connected to such cargo or fuel tanks.

(c) Such inspections shall be made and evidenced as follows:

(1) In ports or places in the United States or its territories and possessions the inspection shall be made by a Marine Chemist certificated by the National Fire Protection Association; however, if the services of such certified Marine Chemist are not reasonably available, the Officer in Charge, Marine Inspection, upon the recommendation of the vessel owner and his contractor or their representative, shall select a person who, in the case of an individual vessel, shall be authorized to make such inspection. If the inspection indicated that such operations can be undertaken with safety, a certificate setting forth the fact in writing and qualified as may be required, shall be issued by the certified Marine Chemist or the authorized person before the work is started. Such qualifications shall include any requirements as may be deemed necessary to maintain, insofar as can reasonably be done, the safe conditions in the spaces certified throughout the operation and shall include such additional tests and certifications as considered required. Such qualifications and requirements shall include precautions necessary to eliminate or minimize hazards that may be present from protective coatings or residues from cargoes.

Subpart C—Surface Preparation and Preservation

§ 1915.31 Scope and application of subpart.

The standards contained in this subpart shall apply to ship repairing and shipbuilding and shall not apply to shipbreaking.

§ 1915.32 Toxic cleaning solvents.

(a) When toxic solvents are used, the employer shall employ one or more of the following measures to safeguard the health of employees exposed to these solvents.

(1) The cleaning operation shall be completely enclosed to prevent the escape of vapor into the working space.

(2) Either natural ventilation or mechanical exhaust ventilation shall be used to remove the vapor at the source and to dilute the concentration of vapors in the working space to a concentration which is safe for the entire work period.

(3) Employees shall be protected against toxic vapors by suitable respiratory protective equipment in accordance with the requirements of subpart I of this part and, where necessary, against exposure of skin and eye contact with toxic solvents and their vapors by suitable clothing and equipment.

(b) The principles in the threshold limit values to which attention is directed in § 1915.4 will be used by the Department of Labor in enforcement proceedings in defining a safe concentration of air contaminants.

(c) When flammable solvents are used, precautions shall be taken in accordance with the requirements of § 1915.36.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.33 Chemical paint and preservative removers.

(a) Employees shall be protected against skin contact during the handling and application of chemical paint and preservative removers and shall be

protected against eye injury by goggles or face shields in accordance with the requirements of subpart I of this part.

(b) When using flammable paint and preservative removers, precautions shall be taken in accordance with the requirements of § 1915.36.

(c) When using chemical paint and preservative removers which contain volatile and toxic solvents, such as benzol, acetone and amyl acetate, the provisions of § 1915.32 shall be applicable.

(d) When using paint and rust removers containing strong acids or alkalies, employees shall be protected by suitable face shields to prevent chemical burns on the face and neck.

(e) When steam guns are used, all employees working within range of the blast shall be protected by suitable face shields. Metal parts of the steam gun itself shall be insulated to protect the operator against heat burns.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.34 Mechanical paint removers.

(a) *Power tools.* (1) Employees engaged in the removal of paints, preservatives, rusts, or other coatings by means of power tools shall be protected against eye injury by using goggles or face shields in accordance with the requirements of subpart I of this part.

(2) All portable rotating tools used for the removal of paints, preservatives, rusts or other coatings shall be adequately guarded to protect both the operator and nearby workers from flying missiles.

(3) Portable electric tools shall be grounded in accordance with the requirements of § 1915.132.

(4) In a confined space, mechanical exhaust ventilation sufficient to keep the dust concentration to a minimum shall be used, or employees shall be protected by respiratory protective equipment in accordance with the requirements of subpart I of this part.

(b) *Flame removal.* (1) Hardened preservative coatings shall not be removed by flame in enclosed spaces unless the employees exposed to fumes are protected by air line respirators in accordance with the requirements of subpart I. Employees performing such an operation in the open air, and those exposed to the resulting fumes shall be protected by a fume filter type respirator in accordance with the requirements of subpart I of this part.

(2) Flame or heat shall not be used to remove soft and greasy preservative coatings.

(c) *Abrasive blasting*—(1) *Equipment.* Hoses and fittings used for abrasive blasting shall meet the following requirements:

(i) *Hoses.* Hose of a type to prevent shocks from static electricity shall be used.

(ii) *Hose couplings.* Hose lengths shall be joined by metal couplings secured to the outside of the hose to avoid erosion and weakening of the couplings.

(iii) *Nozzles.* Nozzles shall be attached to the hose by fittings that will prevent the nozzle from unintentionally becoming disengaged. Nozzle attachments shall be of metal and shall fit onto the hose externally.

(iv) *Dead man control.* A dead man control device shall be provided at the nozzle end of the blasting hose either to provide direct cutoff or to signal the pot tender by means of a visual and audible signal to cut off the flow, in the event the blaster loses control of the hose. The pot tender shall be available at all times to respond immediately to the signal.

(2) *Replacement.* Hoses and all fittings used for abrasive blasting shall be inspected frequently to insure timely replacement before an unsafe amount of wear has occurred.

(3) *Personal protective equipment.* (i) Abrasive blasters working in enclosed spaces shall be protected by hoods and air line respirators, or by air helmets of a positive pressure type in accordance with the requirements of subpart I of this part.

(ii) Abrasive blasters working in the open shall be protected as indicated in paragraph (c)(3)(i) of this section except that when synthetic abrasive containing less than one percent free silica are used, filter type respirators approved jointly by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration for exposure to lead dusts, used in conjunction with the proper eye, face and head protection,

may be used in accordance with subpart I of this part.

(iii) Employees, other than blasters, including machine tenders and abrasive recovery men, working in areas where unsafe concentrations of abrasive materials and dusts are present shall be protected by eye and respiratory protective equipment in accordance with the requirements of subpart I of this part.

(iv) The blaster shall be protected against injury from exposure to the blast by appropriate protective clothing, including gloves.

(v) Since surges from drops in pressure in the hose line can be of sufficient proportions to throw the blaster off the staging, the blaster shall be protected by a safety belt when blasting is being done from elevations where adequate protection against falling cannot be provided by railings.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.35 Painting.

(a) *Paints mixed with toxic vehicles or solvents.* (1) When paints mixed with toxic vehicles or solvents are sprayed, the following conditions shall apply:

(i) In confined spaces, employees continuously exposed to such spraying shall be protected by air line respirators in accordance with the requirements of subpart I of this part.

(ii) In tanks or compartments, employees continuously exposed to such spraying shall be protected by air line respirators in accordance with the requirements of subpart I. Where mechanical ventilation is provided, employees shall be protected by respirators in accordance with the requirements of subpart I of this part.

(iii) In large and well ventilated areas, employees exposed to such spraying shall be protected by respirators in accordance with the requirements of subpart I of this part.

(2) Where brush application of paints with toxic solvents is done in confined spaces or in other areas where lack of ventilation creates a hazard, employees shall be protected by filter respirators in accordance with the requirements of subpart I of this part.

(3) When flammable paints or vehicles are used, precautions shall be taken in accordance with the requirements of § 1915.36.

(4) The metallic parts of air moving devices, including fans, blowers, and jet-type air movers, and all duct work shall be electrically bonded to the vessel's structure.

(b) *Paints and tank coatings dissolved in highly volatile, toxic and flammable solvents.* Several organic coatings, adhesives and resins are dissolved in highly toxic, flammable and explosive solvents with flash points below 80 °F. Work involving such materials shall be done only when all of the following special precautions have been taken:

(1) Sufficient exhaust ventilation shall be provided to keep the concentration of solvent vapors below ten (10) percent of the lower explosive limit. Frequent tests shall be made by a competent person to ascertain the concentration.

(2) If the ventilation fails or if the concentration of solvent vapors rises above ten (10) percent of the lower explosive limit, painting shall be stopped and the compartment shall be evacuated until the concentration again falls below ten (10) percent of the lower explosive limit. If the concentration does not fall when painting is stopped, additional ventilation to bring the concentration down to ten (10) percent of the lower explosive limit shall be provided.

(3) Ventilation shall be continued after the completion of painting until the space or compartment is gas free. The final determination as to whether the space or compartment is gas free shall be made after the ventilating equipment has been shut off for at least 10 minutes.

(4) Exhaust ducts shall discharge clear of working areas and away from sources of possible ignition. Periodic tests shall be made to ensure that the exhausted vapors are not accumulating in other areas within or around the vessel or dry dock.

(5) All motors and control equipment shall be of the explosion-proof type. Fans shall have nonferrous blades. Portable air ducts shall also be of nonferrous materials. All motors and associated control equipment shall be properly maintained and grounded.

(6) Only non-sparking paint buckets, spray guns and tools shall be used. Metal parts of paint brushes and rollers shall be insulated. Staging shall be erected in a manner which ensures that it is non-sparking.

(7) Only explosion proof lights, approved by the Underwriters' Laboratories for use in Class I, Group D atmospheres, or approved as permissible by the Mine Safety and Health Administration or the U.S. Coast Guard, shall be used.

(8) A competent person shall inspect all power and lighting cables to ensure that the insulation is in excellent condition, free of all cracks and worn spots, that there are no connections within fifty (50) feet of the operation, that lines are not overloaded, and that they are suspended with sufficient slack to prevent undue stress or chafing.

(9) The face, eyes, head, hands, and all other exposed parts of the bodies of employees handling such highly volatile paints shall be protected. All footwear shall be non-sparking, such as rubbers, rubber boots or rubber soled shoes without nails. Coveralls or other outer clothing shall be of cotton. Rubber, rather than plastic, gloves shall be used because of the danger of static sparks.

(10) No matches, lighted cigarettes, cigars, or pipes, and no cigarette lighters or ferrous articles shall be taken into the area where work is being done.

(11) All solvent drums taken into the compartment shall be placed on nonferrous surfaces and shall be grounded to the vessel. Metallic contact shall be maintained between containers and drums when materials are being transferred from one to another.

(12) Spray guns, paint pots, and metallic parts of connecting tubing shall be electrically bonded, and the bonded assembly shall be grounded to the vessel.

(13) All employees continuously in a compartment in which such painting is being performed shall be protected by air line respirators in accordance with the requirements of subpart I of this part and by suitable protective clothing. Employees entering such compartments for a limited time shall be protected by filter cartridge type respirators in accordance with the requirements of subpart I of this part.

(14) All employees doing exterior paint spraying with such paints shall be protected by suitable filter cartridge type respirators in accordance with the requirements of subpart I of this part and by suitable protective clothing.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.36 Flammable liquids.

(a) In all cases when liquid solvents, paint and preservative removers, paints or vehicles, other than those covered by §1915.35(b), are capable of producing a flammable atmosphere under the conditions of use, the following precautions shall be taken:

(1) Smoking, open flames, arcs and spark-producing equipment shall be prohibited in the area.

(2) Ventilation shall be provided in sufficient quantities to keep the concentration of vapors below ten (10) percent of their lower explosive limit. Frequent tests shall be made by a competent person to ascertain the concentration.

(3) Scrapings and rags soaked with these materials shall be kept in a covered metal container.

(4) Only explosion proof lights, approved by the Underwriters' Laboratories for use in Class I, Group D atmospheres, or approved as permissible by the Mine Safety and Health Administration or the U.S. Coast Guard, shall be used.

(5) A competent person shall inspect all power and lighting cables to ensure that the insulation is in excellent condition, free of all cracks and worn spots, that there are no connections within fifty (50) feet of the operation, that lines are not overloaded, and that they are suspended with sufficient slack to prevent undue stress or chafing.

(6) Suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use.

Subpart D—Welding, Cutting and Heating

§ 1915.51 Ventilation and protection in welding, cutting and heating.

(a) The provisions of this section shall apply to all ship repairing, shipbuilding, and shipbreaking operations; except that paragraph (e) of this section shall apply only to ship repairing and shipbuilding. Paragraph (g) of this section shall apply only to ship repairing.

(b) *Mechanical ventilation requirements.* (1) For purposes of this section, mechanical ventilation shall meet the following requirements:

(i) Mechanical ventilation shall consist of either general mechanical ventilation systems or local exhaust systems.

(ii) General mechanical ventilation shall be of sufficient capacity and so arranged as to produce the number of air changes necessary to maintain welding fumes and smoke within safe limits.

(iii) Local exhaust ventilation shall consist of freely movable hoods intended to be placed by the welder or burner as close as practicable to the work. This system shall be of sufficient capacity and so arranged as to remove fumes and smoke at the source and keep the concentration of them in the breathing zone within safe limits.

(iv) Contaminated air exhausted from a working space shall be discharged into the open air or otherwise clear of the source of intake air.

(v) All air replacing that withdrawn shall be clean and respirable.

(vi) Oxygen shall not be used for ventilation purposes, comfort cooling, blowing dust or dirt from clothing, or for cleaning the work area.

(c) *Welding, cutting and heating in confined spaces.* (1) Except as provided in paragraphs (c)(3) and (d)(2) of this section either general ventilation meeting the requirements of paragraph (b) of this section shall be provided whenever welding, cutting or heating is performed in a confined space.

(2) The means of access shall be provided to a confined space and ventilation ducts to this space shall be arranged in accordance with § 1915.76(b)(1) and (2).

(3) When sufficient ventilation cannot be obtained without blocking the means of access, employees in the confined space shall be protected by air line respirators in accordance with the requirements of § 1915.152(a), and an employee on the outside of such a confined space shall be assigned to maintain communication with those working within it and to aid them in an emergency.

(d) *Welding, cutting or heating of metals of toxic significance.* (1) Welding, cutting or heating in any enclosed spaces aboard the vessel involving the metals specified below shall be performed with either general mechanical or local exhaust ventilation meeting the requirements of paragraph (a) of this section:

(i) Zinc-bearing base or filler metals or metals coated with zinc-bearing materials.

(ii) Lead base metals.

(iii) Cadmium-bearing filler materials.

(iv) Chromium-bearing metals or metals coated with chromium-bearing materials.

(2) Welding, cutting or heating in any enclosed spaces aboard the vessel involving the metals specified below shall be performed with local exhaust ventilation in accordance with the requirements of paragraph (b) of this section or employees shall be protected by air line respirators in accordance with the requirements of § 1915.152(a):

(i) Metals containing lead, other than as an inpurity, or metals coated with lead-bearing materials.

(ii) Cadmium-bearing or cadmium coated base metals.

(iii) Metals coated with mercury-bearing metals.

(iv) Beryllium-containing base or filler metals. Because of its high toxicity, work involving beryllium shall be done with both local exhaust ventilation and air line respirators.

(3) Employees performing such operations in the open air shall be protected by filter type respirators in accordance with the requirements of paragraphs (a) and (d)(2)(iv) of § 1915.152, except that employees performing such operations on beryllium-containing base or filler metals shall be protected by air line respirators in

accordance with the requirements of § 1915.152(a).

(4) Other employees exposed to the same atmosphere as the welders or burners shall be protected in the same manner as the welder or burner.

(e) *Inert-gas metal-arc welding.* (1) Since the inert-gas metal-arc welding process involves the production of ultraviolet radiation of intensities of 5 to 30 times that produced during shielded metal-arc welding, the decomposition of chlorinated solvents by ultraviolet rays, and the liberation of toxic fumes and gases, employees shall not be permitted to engage in, or be exposed to the process until the following special precautions have been taken:

(i) The use of chlorinated solvents shall be kept at least two hundred (200) feet from the exposed arc, and surfaces prepared with chlorinated solvents shall be thoroughly dry before welding is permitted on such surfaces.

(ii) Helpers and other employees in the area not protected from the arc by screening as provided in § 1915.56(e) shall be protected by filter lenses meeting the requirements of § 1915.151 (a) and (c). When two or more welders are exposed to each other's arc, filter lens goggles of a suitable type meeting the requirements of § 1915.151 (a) and (c) shall be worn under welding helmets or hand shields to protect the welder against flashes and radiant energy when either the helmet is lifted or the shield is removed.

(iii) Welders and other employees who are exposed to radiation shall be suitably protected so that the skin is covered completely to prevent burns and other damage by ultraviolet rays. Welding helmets and hand shields shall be free of leaks and openings, and free of highly reflective surfaces.

(iv) When inert-gas metal-arc welding is being performed on stainless steel, the requirements of paragraph (d)(2) of this section shall be met to protect against dangerous concentrations of nitrogen dioxide.

(f) *General welding, cutting, and heating.* (1) Welding, cutting and heating not involving conditions or materials described in paragraph (c), (d) or (e) of this section may normally be done without mechanical ventilation or respiratory protective equipment, but where, because of unusual physical or atmospheric conditions, an unsafe accumulation of contaminants exists, suitable mechanical ventilation or respiratory protective equipment shall be provided.

(2) Employees performing any type of welding, cutting or heating shall be protected by suitable eye protective equipment in accordance with the requirements of § 1915.151 (a) and (c).

(g) *Residues and cargoes of metallic ores.* (1) Residues and cargoes of metallic ores of toxic significance shall be removed from the area or protected from the heat before ship repair work which involves welding, cutting or heating is begun.

§ 1915.52 Fire prevention.[1]

(a) Paragraph (a) applies to ship repairing, shipbuilding and shipbreaking, and paragraph (b) applies to ship repairing and shipbuilding only.

(1) When practical, objects to be welded, cut or heated shall be moved to a designated safe location or, if the object to be welded, cut or heated cannot be readily moved, all movable fire hazards including residues of combustible bulk cargoes in the vicinity shall be taken to a safe place.

(2) If the object to be welded, cut or heated cannot be moved and if all the fire hazards including combustible cargoes cannot be removed, positive means shall be taken to confine the heat, sparks, and slag, and to protect the immovable fire hazards from them.

(3) When welding, cutting or heating is performed on tank shells, decks, overheads and bulkheads, since direct penetration of sparks or heat tranfer may introduce a fire hazard to an adjacent compartment, the same precautions shall be taken on the opposite side as are taken on the side on which the welding is being performed.

(4) In order to eliminate the possibility of fire in confined spaces as a result of gas escaping through leaking or improperly closed torch valves, the gas supply to the torch shall be positively

[1] 46 CFR 146.02–20 contains Coast Guard regulations pertaining to welding and cutting while explosives and dangerous cargoes are being handled.

shut off at some point outside the confined space whenever the torch is not to be used or whenever the torch is left unattended for a substantial period of time, such as during the lunch hour. Overnight and at the change of shifts, the torch and hose shall be removed from the confined space. Open end fuel gas and oxygen hoses shall be immediately removed from confined spaces when they are disconnected from the torch or other gas consuming device.

(b) The provisions of this paragraph shall apply to ship repairing and shipbuilding only.

(1) No welding, cutting or heating shall be done where the application of flammable paints or the presence of other flammable compounds or of heavy dust concentrate creates a hazard.

(2) Suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use. In addition, when hot work is being performed aboard a vessel and pressure is not available on the vessel's fire system, an auxiliary supply of water shall be made available where practicable, consistent with avoiding freezing of the lines or hose.

(3) When the welding, cutting, or heating operation is such that normal fire prevention precautions are not sufficient, additional personnel shall be assigned to guard against fire while the actual welding, cutting, or heating operation is being performed and for a sufficient period of time after completion of the work to insure that no possibility of fire exists. Such personnel shall be instructed as to the specific anticipated fire hazards and how the fire fighting equipment provided is to be used.

(4) Vaporizing liquid extinguishers shall not be used in enclosed spaces.

(5) Except when the contents are being removed or transferred, drums, pails, and other containers which contain or have contained flammable liquids shall be kept closed. Empty containers shall be removed to a safe area apart from hot work operations, or open flames.

(c) In all cases, suitable fire extinguishing equipment shall be immediately available in the work area and shall be maintained in a state of readiness for instant use. Personnel assigned to contain fires within controllable limits shall be instructed as to the specific anticipated fire hazards and how the fire fighting equipment provided is to be used. The provisions of this paragraph shall apply to shipbreaking only.

§ 1915.53 Welding, cutting and heating in way of preservative coatings.

(a) The provisions in this section shall apply to all ship repairing, shipbuilding and shipbreaking operations except for paragraphs (e) and (f) of this section which shall apply to ship repairing and shipbulding and shall not apply to shipbreaking.

(b) Before welding, cutting or heating is commenced on any surface covered by a preservative coating whose flammability is not known, a test shall be made by a competent person to determine its flammability. Preservative coatings shall be considered to be highly flammable when scrapings burn with extreme rapidity.

(c) Precautions shall be taken to prevent ignition of highly flammable hardened preservative coatings. When coatings are determined to be highly flammable they shall be stripped from the area to be heated to prevent ignition, or, where shipbreaking is involved, the coatings may be burned away under controlled conditions. A 1½ inch or larger fire hose with fog nozzle, which has been uncoiled and placed under pressure, shall be immediately available for instant use in the immediate vicinity, consistent with avoiding freezing of the hose.

(d) *Protection against toxic preservative coatings.* (1) In enclosed spaces, all surfaces covered with toxic preservatives shall be stripped of all toxic coatings for a distance of at least 4 inches from the area of heat application or the employees shall be protected by air line respirators meeting the requirements of § 1915.152(a).

(2) In the open air, employees shall be protected by a filter type respirator in accordance with the requirements of § 1915.152 (a) and (d).

(e) Before welding, cutting or heating is commenced in enclosed spaces on

metals covered by soft and greasy preservatives, the following precautions shall be taken:

(1) A competent person shall test the atmosphere in the space to ensure that it does not contain explosive vapors, since there is a possibility that some soft and greasy preservatives may have flash points below temperatures which may be expected to occur naturally. If such vapors are determined to be present, no hot work shall be commenced until such precautions have been taken as will ensure that the welding, cutting or heating can be performed in safety.

(2) The preservative coatings shall be removed for a sufficient distance from the area to be heated to ensure that the temperature of the unstripped metal will not be appreciably raised. Artificial cooling of the metal surrounding the heated area may be used to limit the size of the area required to be cleaned. The prohibition contained in § 1915.34(b)(2) shall apply.

(f) Immediately after welding, cutting or heating is commenced in enclosed spaces on metal covered by soft and greasy preservatives, and at frequent intervals thereafter, a competent person shall make tests to ensure that no flammable vapors are being produced by the coatings. If such vapors are determined to be present, the operation shall be stopped immediately and shall not be resumed until such additional precautions have been taken as are necessary to ensure that the operation can be resumed safely.

§ 1915.54 Welding, cutting and heating of hollow metal containers and structures not covered by § 1915.12.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Drums, containers, or hollow structures which have contained flammable substances shall, before welding, cutting, or heating is undertaken on them, either be filled with water or thoroughly cleaned of such substances and ventilated and tested.

(b) Before heat is applied to a drum, container, or hollow structure, a vent or opening shall be provided for the release of any built-up pressure during the application of heat.

(c) Before welding, cutting, heating or brazing is begun on structural voids such as skegs, bilge keels, fair waters, masts, booms, support stanchions, pipe stanchions or railings, a competent person shall inspect the object and, if necessary, test it for the presence of flammable liquids or vapors. If flammable liquids or vapors are present, the object shall be made safe.

(d) Objects such as those listed in paragraph (c) of this section shall also be inspected to determine whether water or other non-flammable liquids are present which, when heated, would build up excessive pressure. If such liquids are determined to be present, the object shall be vented, cooled, or otherwise made safe during the application of heat.

(e) Jacketed vessels shall be vented before and during welding, cutting or heating operations in order to release any pressure which may build up during the application of heat.

§ 1915.55 Gas welding and cutting.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *Transporting, moving and storing compressed gas cylinders.* (1) Valve protection caps shall be in place and secure. Oil shall not be used to lubricate protection caps.

(2) When cylinders are hoisted, they shall be secured on a cradle, slingboard or pallet. They shall not be hoisted by means of magnets or choker slings.

(3) Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dropped, struck, or permitted to strike each other violently.

(4) When cylinders are transported by vehicle, they shall be secured in position.

(5) Valve protection caps shall not be used for lifting cylinders from one vertical position to another. Bars shall not be used under valves or valve protection caps to pry cylinders loose when frozen. Warm, not boiling, water shall be used to thaw cylinders loose.

(6) Unless cylinders are firmly secured on a special carrier intended for this purpose, regulators shall be removed and valve protection caps put in place before cylinders are moved.

(7) A suitable cylinder truck, chain, or other steadying device shall be used to keep cylinders from being knocked over while in use.

(8) When work is finished, when cylinders are empty or when cylinders are moved at any time, the cylinder valves shall be closed.

(9) Acetylene cylinders shall be secured in an upright position at all times except, if necessary, for short periods of time while cylinders are actually being hoisted or carried.

(b) *Placing cylinders.* (1) Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag or flame will not reach them. When this is impractical, fire resistant shields shall be provided.

(2) Cylinders shall be placed where they cannot become part of an electrical circuit. Electrodes shall not be struck against a cylinder to strike an arc.

(3) Fuel gas cylinders shall be placed with valve end up whenever they are in use. They shall not be placed in a location where they would be subject to open flame, hot metal, or other sources of artificial heat.

(4) Cylinders containing oxygen or acetylene or other fuel gas shall not be taken into confined spaces.

(c) *Treatment of cylinders.* (1) Cylinders, whether full or empty, shall not be used as rollers or supports.

(2) No person other than the gas supplier shall attempt to mix gases in a cylinder. No one except the owner of the cylinder or person authorized by him shall refill a cylinder. No one shall use a cylinder's contents for purposes other than those intended by the supplier. Only cylinders bearing Interstate Commerce Commission identification and inspection markings shall be used.

(3) No damaged or defective cylinder shall be used.

(d) *Use of fuel gas.* The employer shall thoroughly instruct employees in the safe use of fuel gas, as follows:

(1) Before connecting a regulator to a cylinder valve, the valve shall be opened slightly and closed immediately. (This action is generally termed ''cracking'' and is intended to clear the valve of dust or dirt that might otherwise enter the regulator.) The person cracking the valve shall stand to one side of the outlet, not in front of it. The valve of a fuel gas cylinder shall not be cracked where the gas would reach welding work, sparks, flame or other possible sources of ignition.

(2) The cylinder valve shall always be opened slowly to prevent damage to the regulator. To permit quick closing, valves on fuel gas cylinders shall not be opened more than 1½ turns. When a special wrench is required, it shall be left in position on the stem of the valve while the cylinder is in use so that the fuel gas flow can be shut off quickly in case of an emergency. In the case of manifolded or coupled cylinders, at least one such wrench shall always be available for immediate use. Nothing shall be placed on top of a fuel gas cylinder, when in use, which may damage the safety device or interfere with the quick closing of the valve.

(3) Fuel gas shall not be used from cylinders through torches or other devices which are equipped with shut-off valves without reducing the pressure through a suitable regulator attached to the cylinder valve or manifold.

(4) Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

(5) If, when the valve on a fuel gas cylinder is opened, there is found to be a leak around the valve stem, the valve shall be closed and the gland nut tightened. If this action does not stop the leak, the use of the cylinder shall be discontinued, and it shall be properly tagged and removed from the vessel. In the event that fuel gas should leak from the cylinder valve rather than from the valve stem and the gas cannot be shut off, the cylinder shall be properly tagged and removed from the vessel. If a regulator attached to a cylinder valve will effectively stop a leak through the valve seat, the cylinder need not be removed from the vessel.

(6) If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the vessel

(e) *Fuel gas and oxygen manifolds.* (1) Fuel gas and oxygen manifolds shall bear the name of the substance they contain in letters at least one (1) inch high which shall be either painted on

the manifold or on a sign permanently attached to it.

(2) Fuel gas and oxygen manifolds shall be placed in safe and accessible locations in the open air. They shall not be located within enclosed spaces.

(3) Manifold hose connections, including both ends of the supply hose that lead to the manifold, shall be such that the hose cannot be interchanged between fuel gas and oxygen manifolds and supply header connections. Adapters shall not be used to permit the interchange of hose. Hose connections shall be kept free of grease and oil.

(4) When not in use, manifold and header hose connections shall be capped.

(5) Nothing shall be placed on top of a manifold, when in use, which will damage the manifold or interfere with the quick closing of the valves.

(f) *Hose.* (1) Fuel gas hose and oxygen hose shall be easily distinguishable from each other. The contrast may be made by different colors or by surface characteristics readily distinguishable by the sense of touch. Oxygen and fuel gas hoses shall not be interchangeable. A single hose having more than one gas passage, a wall failure of which would permit the flow of one gas into the other gas passage, shall not be used.

(2) When parallel sections of oxygen and fuel gas hose are taped together not more than 4 inches out of 8 inches shall be covered by tape.

(3) All hose carrying acetylene, oxygen, natural or manufactured fuel gas, or any gas or substance which may ignite or enter into combustion or be in any way harmful to employees, shall be inspected at the beginning of each shift. Defective hose shall be removed from service.

(4) Hose which has been subjected to flashback or which shows evidence of severe wear or damage shall be tested to twice the normal pressure to which it is subject, but in no case less than two hundered (200) psi. Defective hose or hose in doubtful condition shall not be used.

(5) Hose couplings shall be of the type that cannot be unlocked or disconnected by means of a straight pull without rotary motion.

(6) Boxes used for the stowage of gas hose shall be ventilated.

(g) *Torches.* (1) Clogged torch tip openings shall be cleaned with suitable cleaning wires, drills or other devices designed for such purpose.

(2) Torches shall be inspected at the beginning of each shift for leaking shutoff valves, hose couplings, and tip connections. Defective torches shall not be used.

(3) Torches shall be lighted by friction lighters or other approved devices, and not by matches or from hot work.

(h) *Pressure regulators.* Oxygen and fuel gas pressure regulators including their related gauges shall be in proper working order while in use.

§ 1915.56 Arc welding and cutting.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *Manual electrode holders.* (1) Only manual electrode holders which are specifically designed for arc welding and cutting and are of a capacity capable of safely handling the maximum rated current required by the electrodes shall be used.

(2) Any current carrying parts passing through the portion of the holder which the arc welder or cutter grips in his hand, and the outer surfaces of the jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.

(b) *Welding cables and connectors.* (1) All arc welding and cutting cables shall be of the completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress, taking into account the duty cycle under which the arc welder or cutter is working.

(2) Only cable free from repair or splices for a minimum distance of ten (10) feet from the cable end to which the electrode holder is connected shall be used, except that cables with standard insulated connectors or with splices whose insulating quality is equal to that of the cable are permitted.

(3) When it becomes necessary to connect or splice lengths of cable one to another, substantial insulated connectors of a capacity at least equivalent to that of the cable shall be used. If connections are effected by means of cable

lugs, they shall be securely fastened together to give good electrical contact, and the exposed metal parts of the lugs shall be completely insulated.

(4) Cables in poor repair shall not be used. When a cable other than the cable lead referred to in paragraph (b)(2) of this section becomes worn to the extent of exposing bare conductors, the portion thus exposed shall be protected by means of rubber and friction tapes or other equivalent insulation.

(c) *Ground returns and machine grounding.* (1) A ground return cable shall have a safe current carrying capacity equal to or exceeding the specified maximum output capacity of the arc welding or cutting unit which it services. When a single ground return cable services more than one unit, its safe current carrying capacity shall equal or exceed the total specified maximum output capacities of all the units which it services.

(2) Structures or pipe lines, except pipe lines containing gases of flammable liquids or conduits containing electrical circuits, may be used as part of the ground return circuit, provided that the pipe or structure has a current carrying capacity equal to that required by paragraph (c)(1) of this section.

(3) When a structure or pipe line is employed as a ground return circuit, it shall be determined that the required electrical contact exists at all joints. The generation of an arc, sparks or heat at any point shall cause rejection of the structure as a ground circuit.

(4) When a structure or pipe line is continuously employed as a ground return circuit, all joints shall be bonded, and periodic inspections shall be conducted to ensure that no condition of electrolysis or fire hazard exists by virtue of such use.

(5) The frames of all arc welding and cutting machines shall be grounded either through a third wire in the cable containing the circuit conductor or through a separate wire which is grounded at the source of the current. Grounding circuits, other than by means of the vessel's structure, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.

(6) All ground connections shall be inspected to ensure that they are mechanically strong and electrically adequate for the required current.

(d) *Operating instructions.* Employers shall instruct employees in the safe means of arc welding and cutting as follows:

(1) When electrode holders are to be left unattended, the electrodes shall be removed and the holders shall be so placed or protected that they cannot make electrical contact with employees or conducting objects.

(2) Hot electrode holders shall not be dipped in water, since to do so may expose the arc welder or cutter to electric shock.

(3) When the arc welder or cutter has occasion to leave his work or to stop work for any appreciable length of time, or when the arc welding or cutting machine is to be moved, the power supply switch to the equipment shall be opened.

(4) Any faulty or defective equipment shall be reported to the supervisor.

(e) *Shielding.* Whenever practicable, all arc welding and cutting operations shall be shielded by noncombustible or flame-proof screens which will protect employees and other persons working in the vicinity from the direct rays of the arc.

§ 1915.57 Uses of fissionable material in ship repairing and shipbuilding.

The provisions of this section apply to ship repairing and shipbuilding only.

(a) In activities involving the use of and exposure to sources of ionizing radiation not only on conventionally powered but also on nuclear powered vessels, the applicable provisions of the Nuclear Regulatory Commission's Standards for Protection Against Radiation (10 CFR part 20), relating to protection against occupational radiation exposure, shall apply.

(b) Any activity which involves the use of radiocative material, whether or not under license from the Nuclear Regulatory Commission, shall be performed by competent persons specially trained in the proper and safe operation of such equipment. In the case of

materials used under Commission license, only persons actually licensed, or competent persons under direction and supervision of the licensee, shall perform such work.

Subpart E—Scaffolds, Ladders and Other Working Surfaces

§ 1915.71 Scaffolds or staging.

(a) *Scope and application.* The provisions of this section shall apply to all ship repairing, shipbuilding and shipbreaking operations except that paragraphs (b)(8) through (b)(10) and paragraphs (c) through (f) of this section shall only apply to ship repairing and shipbuilding operations and shall not apply to shipbreaking.

(b) *General requirements.* (1) All scaffolds and their supports whether of lumber, steel or other material, shall be capable of supporting the load they are designed to carry with a safety factor of not less than four (4).

(2) All lumber used in the construction of scaffolds shall be spruce, fir, long leaf yellow pine, Oregon pine or wood of equal strength. The use of hemlock, short leaf yellow pine, or short fiber lumber is prohibited.

(3) Lumber dimensions as given in this subpart are nominal except where given in fractions of an inch.

(4) All lumber used in the construction of scaffolds shall be sound, straight-grained, free from cross grain, shakes and large, loose or dead knots. It shall also be free from dry rot, large checks, worm holes or other defects which impair its strength or durability.

(5) Scaffolds shall be maintained in a safe and secure condition. Any component of the scaffold which is broken, burned or otherwise defective shall be replaced.

(6) Barrels, boxes, cans, loose bricks, or other unstable objects shall not be used as working platforms or for the support of planking intended as scaffolds or working platforms.

(7) No scaffold shall be erected, moved, dismantled or altered except under the supervision of competent persons.

(8) No welding, burning, riveting or open flame work shall be performed on any staging suspended by means of fiber rope.

(9) Lifting bridles on working platforms suspended from cranes shall consist of four legs so attached that the stability of the platform is assured.

(10) Unless the crane hook has a safety latch or is moused, the lifting bridles on working platforms suspended from cranes shall be attached by shackles to the lower lifting block or other positive means shall be taken to prevent them from becoming accidentally disengaged from the crane hook.

(c) *Independent pole wood scaffolds.* (1) All pole uprights shall be set plump. Poles shall rest on a foundation of sufficient size and strength to distribute the loan and to prevent displacement.

(2) In light-duty scaffolds, not more than 24 feet in height, poles may be spliced by overlapping the ends not less than 4 feet and securely nailing them together. A substantial cleat shall be nailed to the lower section to form a support for the upper section except when bolted connections are used.

(3) All other poles to be spliced shall be squared at the ends of each splice, abutted, and rigidly fastened together by not less than two cleats securely nailed or bolted thereto. Each cleat shall overlap each pole end by at least 24 inches and shall have a width equal to the face of the pole to which it is attached. The combined cross sectional area of the cleats shall be not less than the cross sectional area of the pole.

(4) Ledgers shall extend over two consecutive pole spaces and shall overlap the poles at each end by not less than 4 inches. They shall be left in position to brace the poles as the platform is raised with the progress of the work. Ledgers shall be level and shall be securely nailed or bolted to each pole and shall be placed against the inside face of each pole.

(5) All bearers shall be set with their greater dimension vertical and shall extend beyond the ledgers upon which they rest.

(6) Diagonal bracing shall be provided between the parallel poles, and cross bracing shall be provided between the inner and outer poles or from the outer poles to the ground.

(7) Minimum dimensions and spacing of members shall be in accordance with Table E–1 in § 1915.118.

(8) Platform planking shall be in accordance with the requirements of paragraph (i) of this section.

(9) Backrails and toeboards shall be in accordance with the requirements of paragraph (j) of this section.

(d) *Independent pole metal scaffolds.* (1) Metal scaffold members shall be maintained in good repair and free of corrosion.

(2) All vertical and horizontal members shall be fastened together with a coupler or locking device which will form a positive connection. The locking device shall be of a type which has no loose parts.

(3) Posts shall be kept plumb during erection and the scaffold shall be subsequently kept plumb and rigid by means of adequate bracing.

(4) Posts shall be fitted with bases supported on a firm foundation to distribute the load. When wooden sills are used, the bases shall be fastened thereto.

(5) Bearers shall be located at each set of posts, at each level, and at each intermediate level where working platforms are installed.

(6) Tubular bracing shall be applied both lengthwise and crosswise as required.

(7) Platform planking shall be in accordance with the requirements of paragraph (h) of this section.

(8) Backrails and toeboards shall be in accordance with the requirements of paragraph (j) of this section.

(e) *Wood trestle and extension trestle ladders.* (1) The use of trestle ladders, or extension sections or base sections of extension trestle ladders longer than 20 feet is prohibited. The total height of base and extension may, however, be more than 20 feet.

(2) The minimum dimensions of the side rails of the trestle ladder, or the base sections of the extension trestle ladder, shall be as follows:

(i) Ladders up to and including those 16 feet long shall have side rails of not less than 1 5/16 x 2¾ inch lumber.

(ii) Ladders over 16 feet long and up to and including those 20 feet long shall have side tails of not less than 1 5/16 x 3 inch lumber.

(3) The side rails of the extension section of the extension trestle ladder shall be parallel and shall have minimum dimensions as follows:

(i) Ladders up to and including 12 feet long shall have side rails of not less than 1 5/16 x 2¼ inch lumber.

(ii) Ladders over 12 feet long and up to and including those 16 feet long shall have side rails of not less than 1 5/16 x 2½ inch lumber.

(iii) Ladders over 16 feet long and up to and including those 20 feet long shall have side rails of not less than 1 5/16 x 2¾ inch lumber.

(4) Trestle ladders and base sections of extension trestle ladders shall be so spread that when in an open position the spread of the trestle at the bottom, inside to inside, shall be not less than 5½ inches per foot of the length of the ladder.

(5) The width between the side rails at the bottom of the trestle ladder or of the base section of the extension trestle ladder shall be not less than 21 inches for all ladders and sections 6 feet or less in length. For longer lengths of ladder, the width shall be increased at least 1 inch for each additional foot of length. The width between the side rails of the extension section of the trestle ladder shall be not less than 12 inches.

(6) In order to limit spreading, the top ends of the side rails of both the trestle ladder and of the base section of the extension trestle ladder shall be beveled, or of equivalent construction, and shall be provided with a metal hinge.

(7) A metal spreader or locking device to hold the front and back sections in an open position, and to hold the extension section securely in the elevated position, shall be a component of each trestle ladder or extension ladder.

(8) Rungs shall be parallel and level. On the trestle ladder, or on the base section of the extension trestle ladder, rungs shall be spaced not less than 8 inches nor more than 18 inches apart; on the extension section of the extension trestle ladder, rungs shall be spaced not less than 6 inches nor more than 12 inches apart.

(9) Platform planking shall be in accordance with the requirements of paragraph (i) of this section, except

that the width of the platform planking shall not exceed the distance between the siderails.

(10) Backrails and toeboards shall be in accordance with the requirements of paragraph (j) of this section.

(f) *Painters' suspended scaffolds.* (1) The supporting hooks of swinging scaffolds shall be constructed to be equivalent in strength to mild steel or wrought iron, shall be forged with care, shall be not less than ⅞ inch in diameter, and shall be secured to a safe anchorage at all times.

(2) The ropes supporting a swinging scaffold shall be equivalent in strength to first-grade ¾ inch diameter manila rope properly rigged into a set of standard 6 inch blocks consisting of at least one double and one single block.

(3) Manila and wire ropes shall be carefully examined before each operation and thereafter as frequently as may be necessary to ensure their safe condition.

(4) Each end of the scaffold platform shall be supported by a wrought iron or mild steel stirrup or hanger, which in turn is supported by the suspension ropes.

(5) Stirrups shall be constructed so as to be equivalent in strength to wrought iron ¾ inch in diameter.

(6) The stirrups shall be formed with a horizontal bottom member to support the platform, shall be provided with means to support the guardrail and midrail and shall have a loop or eye at the top for securing the supporting hook on the block.

(7) Two or more swinging scaffolds shall not at any time be combined into one by bridging the distance between them with planks or any other form of platform.

(8) No more than two men shall be permitted to work at one time on a swinging scaffold built to the minimum specifications contained in this paragraph. Where heavier construction is used, the number of men permitted to work on the scaffold shall be determined by the size and the safe working load of the scaffold.

(9) Backrails and toeboards shall be in accordance with the requirements of paragraph (j) of this section.

(10) The swinging scaffold platform shall be one of the three types described in paragraphs (f)(11), (12), and (13) of this section.

(11) The ladder-type platform consists of boards upon a horizontal ladder-like structure, referred to herein as the ladder, the side rails of which are parallel. If this type of platform is used the following requirements shall be met.

(i) The width between the side rails shall be no more than 20 inches.

(ii) The side rails of ladders in ladder-type platforms shall be equivalent in strength to a beam of clear straight-grained spruce of the dimensions contained in Table E–2 in § 1915.118.

(iii) The side rails shall be tied together with tie rods. The tie rods shall be not less than 5/16 inch in diameter, located no more than 5 feet apart, pass through the rails, and be riveted up tight against washers at both ends.

(iv) The rungs shall be of straight-grained oak, ash, or hickory, not less than 1⅛ inches diameter, with ⅞ inch tenons mortised into the side rails not less than ⅞ inch and shall be spaced no more than 18 inches on centers.

(v) Flooring strips shall be spaced no more than ⅝ inch apart except at the side rails, where 1 inch spacing is permissible.

(vi) Flooring strips shall be cleated on their undersides.

(12) The plank-type platform consists of planks supported on the stirrups or hangers. If this type of platform is used, the following requirements shall be met:

(i) The planks of plank-type platforms shall be of not less than 2 x 10 inch lumber.

(ii) The platform shall be no more than 24 inches in width.

(iii) The planks shall be tied together by cleats of not less than 1 x 6 inch lumber, nailed on their undersides at intervals of not more than 4 feet.

(iv) The planks shall extend not less than 6 inches nor more than 18 inches beyond the supporting stirrups.

(v) A cleat shall be nailed across the platform on the underside at each end outside the stirrup to prevent the platform from slipping off the stirrup.

(vi) Stirrup supports shall be not more than 10 feet apart.

(13) The beam-type platform consists of longitudinal side stringers with

cross beams set on edge and spaced not more than 4 feet apart on which longitudinal platform planks are laid. If this type platform is used, the following requirements shall be met:

(i) The side stringers shall be of sound, straight-grained lumber, free from knots, and of not less than 2 x 6 inch lumber, set on edge.

(ii) The stringers shall be supported on the stirrups with a clear span between stirrups of not more than 16 feet.

(iii) The stringers shall be bolted to the stirrups by U-bolts passing around the stirrups and bolted through the stringers with nuts drawn up tight on the inside face.

(iv) The ends of the stringers shall extend beyond the stirrups not less than 6 inches nor more than 12 inches at each end of the platform.

(v) The platform shall be supported on cross beams of 2 x 6 inch lumber between the side stringers securely nailed thereto and spaced not more than 4 feet on centers.

(vi) The platform shall be not more than 24 inches wide.

(vii) The platform shall be formed of boards ⅞ inch in thickness by not less than 6 inches in width, nailed tightly together, and extending to the outside face of the stringers.

(viii) The ends of all platform boards shall rest on the top of the cross beams, shall be securely nailed, and at no intermediate points in the length of the platform shall there be any cantilever ends.

(g) *Horse scaffolds.* (1) The minimum dimensions of lumber used in the construction of horses shall be in accordance with Table E–3 in § 1915.118.

(2) Horses constructed of materials other than lumber shall provide the strength, rigidity and security required of horses constructed of lumber.

(3) The lateral spread of the legs shall be equal to not less than one-third of the height of the horse.

(4) All horses shall be kept in good repair, and shall be properly secured when used in staging or in locations where they may be insecure.

(5) Platform planking shall be in accordance with the requirements of paragraph (i) of this section.

(6) Backrails and toeboards shall be in accordance with paragraph (j) of this section.

(h) *Other types of scaffolds.* (1) Scaffolds of a type for which specifications are not contained in this section shall meet the general requirements of paragraphs (b), (i), and (j) of this section, shall be in accordance with recognized principles of design and shall be constructed in accordance with accepted standards covering such equipment.

(i) *Scaffold or platform planking.* (1) Except as otherwise provided in paragraphs (f)(11) and (13) of this section, platform planking shall be of not less than 2 x 10 inch lumber. Platform planking shall be straight-grained and free from large or loose knots and may be either rough or dressed.

(2) Platforms of staging shall be not less than two 10 inch planks in width except in such cases as the structure of the vessel or the width of the trestle ladders make it impossible to provide such a width.

(3) Platform planking shall project beyond the supporting members at either end by at least 6 inches but in no case shall project more than 12 inches unless the planks are fastened to the supporting members.

(4) Table E–4 in § 1915.118 shall be used as a guide in determining safe loads for scaffold planks.

(j) *Backrails and toeboards.* (1) Scaffolding, staging, runways, or working platforms which are supported or suspended more than 5 feet above a solid surface, or at any distance above the water, shall be provided with a railing which has a top rail whose upper surface is from 42 to 45 inches above the upper surface of the staging, platform, or runway and a midrail located halfway between the upper rail and the staging, platform, or runway.

(2) Rails shall be of 2 x 4 inch lumber, flat bar or pipe. When used with rigid supports, taut wire or fiber rope of adequate strength may be used. If the distance between supports is more than 8 feet, rails shall be equivalent in strength to 2 x 4 inch lumber. Rails shall be firmly secured. Where exposed to hot work or chemicals, fiber rope rails shall not be used.

(3) Rails may be omitted where the structure of the vessel prevents their

use. When rails are omitted, employees working more than 5 feet above solid surfaces shall be protected by safety belts and life lines meeting the requirements of § 1915.154(b), and employees working over water shall be protected by buoyant work vests meeting the requirements of § 1915.154(a).

(4) Employees working from swinging scaffolds which are triced out of a vertical line below their supports or from scaffolds on paint floats subject to surging, shall be protected against falling toward the vessel by a railing or a safety belt and line attached to the backrail.

(5) When necessary, to prevent tools and materials from falling on men below, toeboards of not less than 1 x 4 inch lumber shall be provided.

(k) *Access to staging.* (1) Access from below to staging more than 5 feet above a floor, deck or the ground shall consist of well secured stairways, cleated ramps, fixed or portable ladders meeting the applicable requirements of § 1915.72 or rigid type non-collapsible trestles with parallel and level rungs.

(2) Ramps and stairways shall be provided with 36-inch handrails with midrails.

(3) Ladders shall be so located or other means shall be taken so that it is not necessary for employees to step more than one foot from the ladder to any intermediate landing or platform.

(4) Ladders forming integral parts of prefabricated staging are deemed to meet the requirements of these regulations.

(5) Access from above to staging more than 3 feet below the point of access shall consist of a straight, portable ladder meeting the applicable requirements of § 1915.72 or a Jacob's ladder properly secured, meeting the requirements of § 1915.74(d).

§ 1915.72 Ladders.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *General requirements.* (1) The use of ladders with broken or missing rungs or steps, broken or split side rails, or other faulty or defective construction is prohibited. When ladders with such defects are discovered, they shall be immediately withdrawn from service. Inspection of metal ladders shall include checking for corrosion of interiors of open end, hollow rungs.

(2) When sections of ladders are spliced, the ends shall be abutted, and not fewer than 2 cleats shall be securely nailed or bolted to each rail. The combined cross sectional area of the cleats shall be not less than the cross sectional area of the side rail. The dimensions of side rails for their total length shall be those specified in paragraph (b) or (c) of this section.

(3) Portable ladders shall be lashed, blocked or otherwise secured to prevent their being displaced. The side rails of ladders used for access to any level shall extend not less than 36 inches above that level. When this is not practical, grab rails which will provide a secure grip for an employee moving to or from the point of access shall be installed.

(4) Portable metal ladders shall be of strength equivalent to that of wood ladders. Manufactured portable metal ladders provided by the employer shall be in accordance with the provisions of the American National Standards Institute Safety Code for Portable Metal Ladders, A14.2—1972.

(5) Portable metal ladders shall not be used near electrical conductors nor for electric arc welding operations.

(6) Manufactured portable wood ladders provided by the employer shall be in accordance with the provisions of the American National Standards Institute Safety Code for Portable Wood Ladders, A14—1975.

(b) *Construction of portable wood cleated ladders up to 30 feet in length.* (1) Wood side rails shall be made from West Coast hemlock, Eastern spruce, Sitka spruce, or wood of equivalent strength. Material shall be seasoned, straight-grained wood, and free from shakes, checks, decay or other defects which will impair its strength. The use of low density woods is prohibited.

(2) Side rails shall be dressed on all sides and kept free of splinters.

(3) All knots shall be sound and hard. The use of material containing loose knots is prohibited. Knots shall not appear on the narrow face of the rail and, when in the side face, shall be not more than ½ inch in diameter or within ½

inch of the edge of the rail or nearer than 3 inches to a tread or rung.

(4) Pitch pockets not exceeding ⅛ inch in width, 2 inches in length and ½ inch in depth are permissible in wood side rails, provided that not more than one such pocket appears in each 4 feet of length.

(5) The width between side rails at the base shall be not less than 11½ inches for ladders 10 feet or less in length. For longer ladders this width shall be increased at least ¼ inch for each additional 2 feet in length.

(6) Side rails shall be at least 1⅝ x 3⅝ inches in cross section.

(7) Cleats (meaning rungs rectangular in cross section with the wide dimension parallel to the rails) shall be of the material used for side rails, straight-grained and free from knots. Cleats shall be mortised into the edges of the side rails ½ inch, or filler blocks shall be used on the rails between the cleats. The cleats shall be secured to each rail with three 10d common wire nails or fastened with through bolts or other fasteners of equivalent strength. Cleats shall be uniformly spaced not more than 12 inches apart.

(8) Cleats 20 inches or less in length shall be at least 25/32 x 3 inches in cross section. Cleats over 20 inches but not more than 30 inches in length shall be at least 25/32 x 3¾ inches in cross section.

(c) *Construction of portable wood cleated ladders from 30 to 60 feet in length.* (1) Ladders from 30 to 60 feet in length shall be in accordance with the specifications of paragraph (b) of this section with the following exceptions:

(i) Rails shall be of not less than 2 x 6 inch lumber.

(ii) Cleats shall be of not less than 1 x 4 inch lumber.

(iii) Cleats shall be nailed to each rail with five 10d common wire nails or fastened with through bolts or other fastenings of equivalent strength.

§ 1915.73 Guarding of deck openings and edges.

(a) The provisions of this section shall apply to ship repairing and shipbuilding operations and shall not apply to shipbreaking.

(b) When employees are working in the vicinity of flush manholes and other small openings of comparable size in the deck and other working surfaces, such openings shall be suitably covered or guarded to a height of not less than 30 inches, except where the use of such guards is made impracticable by the work actually in progress.

(c) When employees are working around open hatches not protected by coamings to a height of 24 inches or around other large openings, the edge of the opening shall be guarded in the working area to height of 36 to 42 inches, except where the use of such guards is made impracticable by the work actually in progress.

(d) When employees are exposed to unguarded edges of decks, platforms, flats, and similar flat surfaces, more than 5 feet above a solid surface, the edges shall be guarded by adequate guardrails meeting the requirements of § 1915.71(j) (1) and (2), unless the nature of the work in progress or the physical conditions prohibit the use or installation of such guardrails.

(e) When employees are working near the unguarded edges of decks of vessels afloat, they shall be protected by personal flotation devices, meeting the requirements of § 1915.154(a).

(f) Sections of bilges from which floor plates or gratings have been removed shall be guarded by guardrails except where they would interfere with work in progress. If these open sections are in a walkway at least two 10-inch planks placed side by side, or equivalent, shall be laid across the opening to provide a safe walking surface.

(g) Gratings, walkways, and catwalks, from which sections or ladders have been removed, shall be barricaded with adequate guardrails.

§ 1915.74 Access to vessels.

(a) *Access to vessels afloat.* The employer shall not permit employees to board or leave any vessel, except a barge or river towboat, until the following requirements have been met:

(1) Whenever practicable, a gangway of not less than 20 inches walking surface of adequate strength, maintained in safe repair and safely secured shall be used. If a gangway is not practicable, a substantial straight ladder, extending at least 36 inches above the upper landing surface and adequately

secured against shifting or slipping shall be provided. When conditions are such that neither a gangway nor a straight ladder can be used, a Jacob's ladder meeting the requirements of paragraphs (d) (1) and (2) of this section may be used.

(2) Each side of such gangway, and the turn table if used, shall have a railing with a minimum height of approximately 33 inches measured perpendicularly from rail to walking surface at the stanchion, with a mid rail. Rails shall be of wood, pipe, chain, wire or rope and shall be kept taut at all times.

(3) Gangways on vessels inspected and certificated by the U.S. Coast Guard are deemed to meet the foregoing requirements, except in cases where the vessel's regular gangway is not being used.

(4) The gangway shall be kept properly trimmed at all times.

(5) When a fixed tread accommodations ladder is used, and the angle is low enough to require employees to walk on the edge of the treads, cleated duckboards shall be laid over and secured to the ladder.

(6) When the lower end of a gangway overhangs the water between the ship and the dock in such a manner that there is danger of employees falling between the ship and the dock, a net or other suitable protection shall be rigged at the foot of the gangway in such a manner as to prevent employees from falling from the end of the gangway.

(7) If the foot of the gangway is more than one foot away from the edge of the apron, the space between them shall be bridged by a firm walkway equipped with railings, with a minimum height of approximately 33 inches with midrails on both sides.

(8) Supporting bridles shall be kept clear so as to permit unobstructed passage for employees using the gangway.

(9) When the upper end of the means of access rests on or flush with the top of the bulwark, substantial steps properly secured and equipped with at least one substantial handrail approximately 33 inches in height shall be provided between the top of the bulwark and the deck.

(10) Obstructions shall not be laid on or across the gangway.

(11) The means of access shall be adequately illuminated for its full length.

(12) Unless the construction of the vessel makes it impossible, the means of access shall be so located that drafts of cargo do not pass over it. In any event, loads shall not be passed over the means of access while employees are on it.

(b) *Access to vessels in drydock or between vessels.* Gangways meeting the requirements of paragraphs (a) (1), (2), (9), (10), (11) of this section shall be provided for access from wingwall to vessel or, when two or more vessels, other than barges or river towboats, are lying abreast, from one vessel to another.

(c) *Access to barges and river towboats.* (1) Ramps for access of vehicles to or between barges shall be of adequate strength, provided with side boards, well maintained and properly secured.

(2) Unless employees can step safely to or from the wharf, float, barge, or river towboat, either a ramp in accordance with the requirements of paragraph (a)(7) of this section shall be provided. When a walkway is impracticable, a substantial straight ladder, extending at least 36 inches above the upper landing surface and adequately secured against shifting or slipping, shall be provided. When conditions are such that neither a walkway nor a straight ladder can be used, a Jacob's ladder in accordance with the requirements of paragraph (d) of this section may be used.

(3) The means of access shall be in accordance with the requirements of paragraphs (a) (9), (10), and (11) of this section.

(d) *Jacob's ladders.* (1) Jacob's ladders shall be of the double rung or flat tread type. They shall be well maintained and properly secured.

(2) A Jacob's ladder shall either hang without slack from its lashings or be pulled up entirely.

§ 1915.75 Access to and guarding of dry docks and marine railways.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) A gangway, ramp or permanent stairway of not less than 20 inches walking surface, of adequate strength, maintained in safe repair and securely fastened, shall be provided between a floating dry dock and the pier or bulkhead.

(b) Each side of such gangway, ramp or permanent stairway, including those which are used for access to wing walls from dry dock floors, shall have a railing with a mid rail. Such railings on gangways or ramps shall be approximately 42 inches in height; and railings on permanent stairways shall be not less than approximately 30 or more than approximately 34 inches in height. Rails shall be of wood, pipe, chain, wire, or rope, and shall be kept taut at all times.

(c) Railings meeting the requirements of paragraph (b) of this section shall be provided on the means of access to and from the floors of graving docks.

(d) Railings approximately 42 inches in height, with a mid rail, shall be provided on the edges of wing walls of floating dry docks and on edges of graving docks. Sections of the railings may be temporarily removed where necessary to permit line handling while a vessel is entering or leaving the dock.

(e) When employees are working on the floor of a floating dry dock where they are exposed to the hazard of falling into the water, the end of the dry dock shall be equipped with portable stanchions and 42 inch railings with a mid rail. When such a railing would be impracticable or ineffective, other effective means shall be provided to prevent men from falling into the water.

(f) Access to wing walls from floors of dry docks shall be by ramps, permanent stairways or ladders meeting the applicable requirements of § 1915.72.

(g) Catwalks on stiles of marine railways shall be no less than 20 inches wide and shall have on at least one side a guardrail and midrail meeting the requirements of § 1915.71(j) (1) and (2).

§ 1915.76 Access to cargo spaces and confined spaces.

The provisions of this section apply to ship repairing, shipbuilding and shipbreaking except that paragraph (a)(4) of this section applies to ship repairing only.

(a) *Cargo spaces.* (1) There shall be at least one safe and accessible ladder in any cargo space which employees must enter.

(2) When any fixed ladder is visibly unsafe, the employer shall prohibit its use by employees.

(3) Straight ladders of adequate strength and suitably secured against shifting or slipping shall be provided as necessary when fixed ladders in cargo spaces do not meet the requirements of paragraph (a)(1) of this section. When conditions are such that a straight ladder cannot be used, a Jacob's ladder meeting the requirements of § 1915.74(d) may be used.

(4) When cargo is stowed within 4 inches of the back of ladder rungs, the ladder shall be deemed ''unsafe'' for the purpose of this section.

(5) Fixed ladders or straight ladders provided for access to cargo spaces shall not be used at the same time that cargo drafts, equipment, materials, scrap or other loads are entering or leaving the hold. Before using these ladders to enter or leave the hold, the employee shall be required to inform the winchman or crane signalman of his intention.

(b) *Confined spaces.* (1) More than one means of access shall be provided to a confined space in which employees are working and in which the work may generate a hazardous atmosphere in the space except where the structure or arrangement of the vessel makes this provision impractical.

(2) When the ventilation ducts required by these regulations must pass through these means of access, the ducts shall be of such a type and so arranged as to permit free passage of an employee through at least two of these means of access.

§ 1915.77 Working surfaces.

(a) Paragraphs (b) through (d) of this section shall apply to ship repairing, shipbuilding operations and shall not apply to shipbreaking. Paragraph (e) of this section shall apply to shipbuilding, ship repairing and shipbreaking operations.

(b) When firebox floors present tripping hazards of exposed tubing or of

missing or removed refractory, sufficient planking to afford safe footing shall be laid while work is being carried on within the boiler.

(c) When employees are working aloft, or elsewhere at elevations more than 5 feet above a solid surface, either scaffolds or a sloping ladder, meeting the requirements of this subpart, shall be used to afford safe footing, or the employees shall be protected by safety belts and lifelines meeting the requirements of § 1915.154(b). Employees visually restricted by blasting hoods, welding helmets, and burning goggles shall work from scaffolds, not from ladders, except for the initial and final welding or burning operation to start or complete a job, such as the erection and dismantling of hung scaffolding, or other similar, nonrepetitive jobs of brief duration.

(d) For work performed in restricted quarters, such as behind boilers and in between congested machinery units and piping, work platforms at least 20 inches wide meeting the requirements of § 1915.71(i)(1) shall be used. Backrails may be omitted if bulkheading, boilers, machinery units, or piping afford proper protection against falling.

(e) When employees are boarding, leaving, or working from small boats or floats, they shall be protected by personal flotation devices meeting the requirements of § 1915.154.

Subpart F—General Working Conditions

§ 1915.91 Housekeeping.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking except that paragraphs (c) and (e) of this section do not apply to shipbreaking.

(a) Good housekeeping conditions shall be maintained at all times. Adequate aisles and passageways shall be maintained in all work areas. All staging platforms, ramps, stairways, walkways, aisles, and passageways on vessels or dry docks shall be kept clear of all tools, materials, and equipment except that which is in use, and all debris such as welding rod tips, bolts, nuts, and similar material. Hose and electric conductors shall be elevated over or placed under the walkway or working surfaces or covered by adequate crossover planks.

(b) All working areas on or immediately surrounding vessels and dry docks, graving docks, or marine railways shall be kept reasonably free of debris, and construction material shall be so piled as not to present a hazard to employees.

(c) Slippery conditions on walkways or working surfaces shall be eliminated as they occur.

(d) Free access shall be maintained at all times to all exits and to all fire-alarm boxes or fire-extinguishing equipment.

(e) All oils, paints thinners, solvents, waste, rags, or other flammable substances shall be kept in fire resistant covered containers when not in use.

§ 1915.92 Illumination.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) All means of access and walkways leading to working areas as well as the working areas themselves shall be adequately illuminated.

(b) Temporary lights shall meet the following requirements:

(1) Temporary lights shall be equipped with guards to prevent accidental contact with the bulb, except that guards are not required when the construction of the reflector is such that the bulb is deeply recessed.

(2) Temporary lights shall be equipped with heavy duty electric cords with connections and insulation maintained in safe condition. Temporary lights shall not be suspended by their electric cords unless cords and lights are designed for this means of suspension. Splices which have insulation equal to that of the cable are permitted.

(3) Cords shall be kept clear of working spaces and walkways or other locations in which they are readily exposed to damage.

(c) Exposed non-current-carrying metal parts of temporary lights furnished by the employer shall be grounded either through a third wire in the cable containing the circuit conductors or through a separate wire which is grounded at the source of the

current. Grounding shall be in accordance with the requirements of § 1915.132(b).

(d) Where temporary lighting from sources outside the vessel is the only means of illumination, portable emergency lighting equipment shall be available to provide illumination for safe movement of employees.

(e) Employees shall not be permitted to enter dark spaces without a suitable portable light. The use of matches and open flame lights is prohibited. In nongas free spaces, portable lights shall meet the requirements of § 1915.13.

(f) Temporary lighting stringers or streamers shall be so arranged as to avoid overloading of branch circuits. Each branch circuit shall be equipped with overcurrent protection of capacity not exceeding the rated current carrying capacity of the cord used.

§ 1915.93 Utilities.

The provisions of this section shall apply to ship repairing, shipbuilding, and shipbreaking except that paragraph (c) of this section applies to ship repairing and shipbuilding only.

(a) *Steam supply and hoses*. (1) Prior to supplying a vessel with steam from a source outside the vessel, the employer shall ascertain from responsible vessel's representatives, having knowledge of the condition of the plant, the safe working pressure of the vessel's steam system. The employer shall install a pressure gauge and a relief valve of proper size and capacity at the point where the temporary steam hose joins the vessel's steam piping system or systems. The relief valve shall be set and capable of relieving at a pressure not exceeding the safe working pressure of the vessel's system in its present condition, and there shall be no means of isolating the relief valve from the system which it protects. The pressure gauge and relief valve shall be located so as to be visible and readily accessible.

(2) Steam hose and fittings shall have a safety factor of not less than five (5).

(3) When steam hose is hung in a bight or bights, the weight shall be relieved by appropriate lines. The hose shall be protected against chafing.

(4) Steam hose shall be protected from damage and hose and temporary piping shall be so shielded where passing through normal work areas as to prevent accidental contact by employees.

(b) *Electric power*. (1) When the vessel is supplied with electric power from a source outside the vessel, the following precautions shall be taken prior to energizing the vessel's circuits:

(i) If in dry dock, the vessel shall be adequately grounded.

(ii) The employer shall ascertain from responsible vessel's representatives, having knowledge of the condition of the vessel's electrical system, that all circuits to be energized are in a safe condition.

(iii) All circuits to be energized shall be equipped with overcurrent protection of capacity not exceeding the rated current carrying capacity of the cord used.

(c) *Infrared electrical heat lamps*. (1) All infrared electrical heat lamps shall be equipped with guards that surround the lamps with the exception of the face, to minimize accidental contact with the lamps.

§ 1915.94 Work in confined or isolated spaces.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking. When any work is performed in a confined space, except as provided in § 1915.51(c)(3), or when an employee is working alone in an isolated location, frequent checks shall be made to ensure the safety of the employees.

§ 1915.95 Ship repairing and shipbuilding work on or in the vicinity of radar and radio.

The provisions of this section shall apply to ship repairing and shipbuilding.

(a) No employees other than radar or radio repairmen shall be permitted to work on masts, king posts or other aloft areas unless the radar and radio are secured or otherwise made incapable of radiation. In either event, the radio and radar shall be appropriately tagged.

(b) Testing of radar or radio shall not be done until the employer can schedule such tests at a time when no work is in progress aloft or personnel can be

cleared from the danger area according to minimum safe distances established for and based on the type, model, and power of the equipment.

[47 FR 16986, Apr. 20, 1982, as amended at 49 FR 18295, Apr. 30, 1984; 54 FR 24334, June 7, 1989]

§ 1915.96 Work in or on lifeboats.

The provisions of this section shall apply to ship repairing, shipbuilding, and shipbreaking except that paragraph (b) of this section applies to ship repairing and shipbuilding only.

(a) Before employees are permitted to work in or on a lifeboat, either stowed or in a suspended position, the employer shall ensure that the boat is secured independently of the releasing gear to prevent the boat from falling due to accidental tripping of the releasing gear and movement of the davits or capsizing of a boat in chocks.

(b) Employees shall not be permitted to remain in boats while the boats are being hoisted into final stowed position.

(c) Employees shall not be permitted to work on the outboard side of lifeboats stowed on their chocks unless the boats are secured by gripes or otherwise secured to prevent them from swinging outboard.

§ 1915.97 Health and sanitation.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking, except where indicated otherwise.

(a) The employer shall provide all necessary controls, and the employees shall be protected by suitable personal protective equipment against the hazards identified under § 1915.99 of this part and those hazards for which specific precautions are required in subparts B, C, and D of this part.

(b) The employer shall provide adequate washing facilities for employees engaged in the application of paints or coatings or in other operations where contaminants can, by ingestion or absorption, be detrimental to the health of the employees. The employer shall encourage good personal hygiene practices by informing the employees of the need for removing surface contaminants by thorough washing or hands and face prior to eating or smoking.

(c) The employer shall not permit employees to eat or smoke in areas undergoing surface preparation or preservation or where shipbreaking operations produce atmospheric contaminants.

(d) The employer shall not permit employees engaged in ship repair work on a vessel to work in the immediate vicinity of uncovered garbage and shall ensure that employees working beneath or on the outboard side of a vessel are not subject to contamination by drainage or waste from overboard discharges.

(e) No minor under 18 years of age shall be employed in shipbreaking or related employments.

[52 FR 31886, Aug. 24, 1987]

§ 1915.98 First aid.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Unless a first aid room and a qualified attendant are close at hand and prepared to render first aid to employees on behalf of the employer, the employer shall furnish a first aid kit for each vessel on which work is being performed, except that when work is being performed on more than one small vessel at one pier, only one kit shall be required. The kit, when required, shall be kept close to the vessel and at least one employee, close at hand, shall be qualified to administer first aid to the injured.

(b) The first aid kit shall consist of a weatherproof container with individual sealed packages for each type of item. The contents of such kit shall contain a sufficient quantity of at least the following types of items:

Gauze roller bandages, 1 inch and 2 inch.
Gauze compress bandages, 4 inch.
Adhesive bandages, 1 inch.
Triangular bandage, 40 inch.
Ammonia inhalants and ampules.
Antiseptic applicators or swabs.
Burn dressing.
Eye dressing.
Wire or thin board splints.
Forceps and tourniquet.

(c) The contents of the first aid kit shall be checked before being sent out on each job and at least weekly on each job to ensure that the expended items are replaced.

(d) There shall be available for each vessel on which ten (10) or more employees are working one Stokes basket stretcher, or equivalent, permanently equipped with bridles for attaching to the hoisting gear, except that no more than two strechers are required on each job location. A blanket or other liner suitable for transferring the patient to and from the stretcher shall be provided. Stretchers shall be kept close to the vessels. This paragraph does not apply where ambulance services which are available are known to carry such stretchers.

§ 1915.100 Retention of DOT markings, placards and labels.

(a) Any employer who receives a package of hazardous material which is required to be marked, labeled or placarded in accordance with the U. S. Department of Transportation's Hazardous Materials Regulations (49 CFR parts 171 through 180) shall retain those markings, labels and placards on the package until the packaging is sufficiently cleaned of residue and purged of vapors to remove any potential hazards.

(b) Any employer who receives a freight container, rail freight car, motor vehicle, or transport vehicle that is required to be marked or placarded in accordance with the Hazardous Materials Regulations shall retain those markings and placards on the freight container, rail freight car, motor vehicle or transport vehicle until the hazardous materials which require the marking or placarding are sufficiently removed to prevent any potential hazards.

(c) Markings, placards and labels shall be maintained in a manner that ensures that they are readily visible.

(d) For non-bulk packages which will not be reshipped, the provisions of this section are met if a label or other acceptable marking is affixed in accordance with the Hazard Communication Standard (29 CFR 1910.1200).

(e) For the purposes of this section, the term ''hazardous material'' and any other terms not defined in this section have the same definition as in the Hazardous Materials Regulations (49 CFR parts 171 through 180).

[59 FR 36700, July 19, 1994]

Subpart G—Gear and Equipment for Rigging and Materials Handling

§ 1915.111 Inspection.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) All gear and equipment provided by the employer for rigging and materials handling shall be inspected before each shift and when necessary, at intervals during its use to ensure that it is safe. Defective gear shall be removed and repaired or replaced before further use.

(b) The safe working load of gear as specified in §§ 1915.112 and 1915.113 shall not be exceeded.

§ 1915.112 Ropes, chains and slings.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *Manila rope and manila rope slings.* (1) Table G–1 in § 1915.118 shall be used to determine the safe working load of various sizes of manila rope and manila rope slings at various angles, except that higher safe working loads are permissible when recommended by the manufacturer for specific, identifiable products, provided that a safety factor of not less than five (5) is maintained.

(b) *Wire rope and wire rope slings.* (1) Tables G–2 through G–5 in § 1915.118 shall be used to determine the safe working loads of various sizes and classifications of improved plow steel wire rope and wire rope slings with various types of terminals. For sizes, classifications and grades not included in these tables, the safe working load recommended by the manufacturer for specific, identifiable products shall be followed, provided that a safety factor of not less than five (5) is maintained.

(2) Protruding ends of strands in splices on slings and bridles shall be covered or blunted.

(3) Where U-bolt wire rope clips are used to form eyes, Table G–6 in § 1915.118 shall be used to determine the number and spacing of clips. The U-bolt shall be applied so that the ''U'' section is in contact with the dead end of the rope.

(4) Wire rope shall not be secured by knots.

(c) *Chains and chain slings.* (1) Tables G–7 and G–8 in § 1915.118 shall be used to determine the working load limit of various sizes of wrought iron and alloy steel chains and chain slings, except that higher safe working loads are permissible when recommended by the manufacturer for specific, identifiable products.

(2) All sling chains, including end fastenings, shall be given a visual inspection before being used on the job. A thorough inspection of all chains in use shall be made every 3 months. Each chain shall bear an indication of the month in which it was thoroughly inspected. The thorough inspection shall include inspection for wear, defective welds, deformation and increase in length or stretch.

(3) Interlink wear, not accompanied by stretch in excess of 5 percent, shall be noted and the chain removed from service when maximum allowable wear at any point of link, as indicated in Table G–9 in § 1915.18 has been reached.

(4) Chain slings shall be removed from service when, due to stretch, the increase in length of a measured section exceeds five (5) percent; when a link is bent, twisted or otherwise damaged; or when raised scarfs or defective welds appear.

(5) All repairs to chains shall be made under qualified supervision. Links or portions of the chain found to be defective as described in paragraph (c)(4) of this section shall be replaced by links having proper dimensions and made of material similar to that of the chain. Before repaired chains are returned to service, they shall be proof tested to the proof test load recommended by the manufacturer.

(6) Wrought iron chains in constant use shall be annealed or normalized at intervals not exceeding six months when recommended by the manufacturer. The chain manufacturer shall be consulted for recommended procedures for annealing or normalizing. Alloy chains shall never be annealed.

(7) A load shall not be lifted with a chain having a kink or knot in it. A chain shall not be shortened by bolting, wiring or knotting.

§ 1915.113 Shackles and hooks.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *Shackles.* (1) Table G–10 in § 1915.118 shall be used to determine the safe working loads of various sizes of shackles, except that higher safe working loads are permissible when recommended by the manufacturer for specific, identifiable products, provided that a safety factor of not less than (5) is maintained.

(b) *Hooks.* (1) The manufacturer's recommendations shall be followed in determining the safe working loads of the various sizes and types of specific and identifiable hooks. All hooks for which no applicable manufacturer's recommendations are available shall be tested to twice the intended safe working load before they are initially put into use. The employer shall maintain and keep readily available a certification record which includes the date of such tests, the signature of the person who performed the test and an identifier for the hook which was tested.

(2) Loads shall be applied to the throat of the hook since loading the point overstresses and bends or springs the hook.

(3) Hooks shall be inspected periodically to see that they have not been bent by overloading. Bent or sprung hooks shall not be used.

[47 FR 16986, Apr. 20, 1982, as amended at 51 FR 34562, Sept. 29, 1986]

§ 1915.114 Chain falls and pull-lifts.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Chain falls and pull-lifts shall be clearly marked to show the capacity and the capacity shall not be exceeded.

(b) Chain falls shall be regularly inspected to ensure that they are safe, particular attention being given to the lift chain, pinion, sheaves and hooks for distortion and wear. Pull-lifts shall be regularly inspected to ensure that they are safe, particular attention being given to the ratchet, pawl, chain and hooks for distortion and wear.

(c) Straps, shackles, and the beam or overhead structure to which a chain

fall or pull-lift is secured shall be of adequate strength to support the weight of load plus gear. The upper hook shall be moused or otherwise secured against coming free of its support.

(d) Scaffolding shall not be used as a point of attachment for lifting devices such as tackles, chain falls, and pull-lifts unless the scaffolding is specifically designed for that purpose.

§ 1915.115 Hoisting and hauling equipment.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) *Derrick and crane certification.* (1) Derricks and cranes which are part of, or regularly placed aboard barges, other vessels, or on wingwalls of floating drydocks, and are used to transfer materials or equipment from or to a vessel or drydock, shall be tested and certificated in accordance with the standards provided in part 1919 of this title by persons accredited for the purpose.

(b) The moving parts of hoisting and hauling equipment shall be guarded.

(c) *Mobile crawler or truck cranes used on a vessel.* (1) The maximum manufacturer's rated safe working loads for the various working radii of the boom and the maximum and minimum radii at which the boom may be safely used with and without outriggers shall be conspicuously posted near the controls and shall be visible to the operator. A radius indicator shall be provided.

(2) The posted safe working loads of mobile crawler or truck cranes under the conditions of use shall not be exceeded.

(d) Accessible areas within the swing radius of the outermost part of the body of a revolving derrick or crane wither permanently or temporarily mounted, shall be guarded in such a manner as to prevent an employee from being in such a position as to be struck by the crane or caught between the crane and fixed parts of the vessel or of the crane itself.

(e) *Marine railways.* (1) The cradle or carriage on the marine railway shall be positively blocked or secured when in the hauled position to prevent it from being accidentally released.

§ 1915.116 Use of gear.

(a) The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking except that paragraphs (c) and (d) of this section shall apply to ship repairing and shipbuilding only.

(b) Loads shall be safely rigged before being hoisted.

(c) Plates shall be handled on and off hulls by means of shackles whenever possible. Clips or pads of ample size shall be welded to the plate to receive the shackle pins when there are no holes in the plate. When it is not possible to make holes in or to weld pads to the plate, alligator tongs, grab clamps or screw clamps may be used. In such cases special precautions shall be taken to keep employees from under such lifts.

(d) Tag lines shall be provided on loads likely to swing or to need guidance.

(e) When slings are secured to eyebolts, the slings shall be so arranged, using spreaders if necessary, that the pull is within 20 degrees of the axis of the bolt.

(f) Slings shall be padded by means of wood blocks or other suitable material where they pass over sharpe edges or corners of loads so as to prevent cutting or kinking.

(g) Skips shall be rigged to be handled by not less than 3 legged bridles, and all legs shall always be used. When open end skips are used, means shall be taken to prevent the contents from falling.

(h) Loose ends of idle legs of slings in use shall be hung on the hook.

(i) Employees shall not be permitted to ride the hook or the load.

(j) Loads (tools, equipment or other materials) shall not be swung or suspended over the heads of employees.

(k) Pieces of equipment or structure susceptible to falling or dislodgement shall be secured or removed as early as possible.

(l) An individual who is familiar with the signal code in use shall be assigned to act as a signalman when the hoist operator cannot see the load being handled. Communications shall be made by means of clear and distinct visual or auditory signals except that verbal signals shall not be permitted.

(m) Pallets, when used, shall be of such material and contruction and so maintained as to safely support and carry the loads being handled on them.

(n) A section of hatch through which materials or equipment are being raised, lowered, moved, or otherwise shifted manually or by a crane, winch, hoist, or derrick, shall be completely opened. The beam or pontoon left in place adjacent to an opening shall be sufficiently lashed, locked or otherwise secured to prevent it from being unshipped so that it cannot be displaced by accident.

(o) Hatches shall not be open or closed while employees are in the square of the hatch below.

(p) Before loads or empty lifting gear are raised, lowered, or swung, clear and sufficient advance warning shall be given to employees in the vincinity of such operations.

(q) At no time shall an employee be permitted to place himself in a hazardous position between a swinging load and a fixed object.

§ 1915.117 Qualifications of operators.

Paragraphs (a) and (d) of this section shall apply to ship repairing and shipbuilding only. Paragraphs (b) and (c) of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) When ship's gear is used to hoist materials aboard, a competent person shall determine that the gear is properly rigged, that it is in safe condition, and that it will not be overloaded by the size and weight of the lift.

(b) Only those employees who understand the signs, notices, and operating instructions, and are familiar with the signal code in use, shall be permitted to operate a crane, winch, or other power operated hoisting apparatus.

(c) No employee known to have defective uncorrected eyesight or hearing, or to be suffering from heart disease, epilepsy, or similar ailments which may suddenly incapacitate him, shall be permitted to operate a crane, winch or other power operated hoisting apparatus.

(d) No minor under eighteen (18) years of age shall be employed in occupations involving the operation of any power-driven hoisting apparatus or assisting in such operations by work such as hooking on, loading slings, rigging gear, etc.

§ 1915.118 Tables.

The provisions of this section apply to ship repairing, shipbuilding and shipbreaking.

TABLE E–1—DIMENSIONS AND SPACING OF WOOD INDEPENDENT-POLE SCAFFOLD MEMBERS

Structural members	Light duty (Up to 25 pounds per square foot)—Height in feet			Heavy duty (25 to 75 pounds per square foot)—Height in feet		
	24 or less	24–40	40–60	24 or less	24–40	40–60
Poles or uprights (in inches)	2 x 4	3 x 4 or 2 x 6	4 x 4	3 x 4	4 x 4	4 x 6
Bearers (in inches)	2 x 6	2 x 6	2 x 6	2 x 8	2 x 8	2 x 10
Ledgers (in inches)	2 x 6	2 x 6	2 x 6	2 x 8	2 x 8	2 x 8
Stringers (not supporting bearers) (in inches)	1 x 6	1 x 6	1 x 6	1 x 6	1 x 6	1 x 6
Braces (in inches)	1 x 4	1 x 6	1 x 6	1 x 6	1 x 6	1 x 6
Pole spacing—longitudinally (in feet)	7½	7½	7½	7	7	7
Pole spacing—transversely (in feet)	6½ min	7½ min	8½ min	6½	10	10
Ledger spacing—vertically (in feet)	7	7	7	4½	4½	4½

TABLE E–2—SPECIFICATIONS FOR SIDE RAILS OF LADDERS

Length (in feet)	Cross section (in inches)	
	At ends	At center
15	1⅞ x 2¾	1⅞ x 3¾
16	1⅞ x 2¾	1⅞ x 3¾
18	1⅞ x 3	1⅞ x 4
20	1⅞ x 3	1⅞ x 4
24	1⅞ x 3	1⅞ x 4½

TABLE E–3—SPECIFICATIONS FOR THE CONSTRUCTION OF HORSES

Structural members	Height in feet		
	Up to 10	10 to 16	16 to 20
	inches	*inches*	*inches*
Legs	2 x 4	3 x 4	4 x 6
Bearers or headers	2 x 6	2 x 8	4 x 6
Crossbraces	2 x 4 or 1 x 8	2 x 4	2 x 6
Longitudinal braces	2 x 4	2 x 6	2 x 6

TABLE E–4—SAFE CENTER LOADS FOR SCAFFOLD PLANK OF 1,100 POUNDS FIBRE STRESS

Span in feet	Lumber dimensions in inches									
	A	B	A	B	A	B	A	B	A	B
	2 x 10	1⅝ x 9½	2 x 12	1⅝ x 11½	3 x 8	2⅝ x 7½	3 x 10	2⅝ x 9½	3 x 12	2⅝ x 11½
6	256		309		526		667		807	
8	192		232		395		500		605	
10	153		186		316		400		484	
12	128		155		263		333		404	
14	110		133		225		286		346	
16	.....		116		197		250		303	

(A)—Rough lumber.
(B)—Dressed lumber.

TABLE G–1—MANILA ROPE

[In pounds or tons of 2,000 pounds]

Circumferences	Diameter in inches	Single leg	60° bridle	45° bridle	30° bridle
		lbs.	lbs.	lbs.	lbs.
¾	¼	120	204	170	120
1	5/16	200	346	282	200
1⅛	⅜	270	467	380	270
1¼	7/16	350	605	493	350
1⅜	15/32	450	775	635	450
1½	½	530	915	798	530
1¾	9/16	690	1190	973	690
2	⅝	880	1520	1240	880
2¼	¾	1080	1870	1520	1080
2½	13/16	1300	2250	1830	1300
2¾	⅞	1540	2660	2170	1540
3	1	1800	3120	2540	1800
		Tons	Tons	Tons	Tons
3¼	1 1/16	1.0	1.7	1.4	1.0
3½	1⅛	1.2	2.1	1.7	1.2
3¾	1¼	1.35	2.3	1.9	1.35
4	1 5/16	1.5	2.6	2.1	1.5
4½	1½	1.8	3.1	2.5	1.8
5	1⅝	2.25	3.9	3.2	2.25
5½	1¾	2.6	4.5	3.7	2.6
6	2	3.1	5.4	4.4	3.1
6½	2⅛	3.6	6.2	5.1	3.6

TABLE G–2—RATED CAPACITIES FOR IMPROVED PLOW STEEL, INDEPENDENT WIRE ROPE CORE, WIRE ROPE AND WIRE ROPE SLINGS

[In tons of 2,000 pounds]

Rope diameter	Single leg					
	Vertical			Choker		
	A	B	C	A	B	C
	6 x 19 Classification					
¼″	.59	.56	.53	.44	.42	.40
⅜″	1.3	1.2	1.1	.98	.93	.86

TABLE G–2—RATED CAPACITIES FOR IMPROVED PLOW STEEL, INDEPENDENT WIRE ROPE CORE, WIRE ROPE AND WIRE ROPE SLINGS—Continued

[In tons of 2,000 pounds]

Rope diameter	Single leg					
	Vertical			Choker		
	A	B	C	A	B	C
½″	2.3	2.2	2.0	1.7	1.6	1.5
⅝″	3.6	3.4	3.0	2.7	2.5	2.2
¾″	5.1	4.9	4.2	3.8	3.6	3.1
⅞″	6.9	6.6	5.5	5.2	4.9	4.1
1″	9.0	8.5	7.2	6.7	6.4	5.4
1⅛″	11	10	9.0	8.5	7.8	6.8
	6 x 37 Classification					
1¼″	13	12	10	9.9	9.2	7.9
1⅜″	16	15	13	12	11	9.6
1½″	19	17	15	14	13	11
1¾″	26	24	20	19	18	15
2″	33	30	26	25	23	20
2¼″	41	38	33	31	29	25

(A)—Socket or Swaged Terminal attachment.
(B)—Mechanical Sleeve attachment.
(C)—Hand Tucked Splice attachment.

TABLE G–3—RATED CAPACITIES FOR IMPROVED PLOW STEEL, INDEPENDENT WIRE ROPE CORE, WIRE ROPE SLINGS

[in tons of 2,000 pounds]

Rope diameter	Two-leg bridle or basket hitch											
	Vertical			60° bridle			45° bridle			30° bridle		
	A	B	C	A	B	C	A	B	C	A	B	C
	6 x 19 Classification											
¼″	1.2	1.1	1.0	1.0	.97	.92	.83	.79	.75	.59	.56	.53
⅜″	2.6	2.5	2.3	2.3	2.1	2.0	1.8	1.8	1.6	1.3	1.2	1.1
½″	4.6	4.4	3.9	4.0	3.8	3.4	3.2	3.1	2.8	2.3	2.2	2.0
⅝″	7.2	6.8	6.0	6.2	5.9	5.2	5.1	4.8	4.2	3.6	3.4	3.0
¾″	10	9.7	8.4	8.9	8.4	7.3	7.2	6.9	5.9	5.1	4.9	4.2
⅞″	14	13	11	12	11	9.6	9.8	9.3	7.8	6.9	6.6	5.5
1″	18	17	14	15	15	12	13	12	10	9.0	8.5	7.2
1⅛″	23	21	18	19	18	16	16	15	13	11	10	9.0
	6 x 37 Classification											
1¼″	26	24	21	23	21	18	19	17	15	13	12	10
1⅜″	32	29	25	28	25	22	22	21	18	16	15	13
1½″	38	35	30	33	30	26	27	25	21	19	17	15
1¾″	51	47	41	44	41	35	36	33	29	26	24	20
2″	66	621	53	57	53	46	47	43	37	33	30	26
2¼″	83	76	66	72	66	57	58	54	47	41	38	33

(A)—Socket or Swaged Terminal Attachment.
(B)—Mechanical Sleeve Attachment.
(C)—Hand Tucked Splice Attachment.

TABLE G–4—RATED CAPACITIES FOR IMPROVED PLOW STEEL, FIBER CORE, WIRE ROPE AND WIRE ROPE SLINGS

[in tons of 2,000 pounds]

Rope diameter	Single leg					
	Vertical			Choker		
	A	B	C	A	B	C
	6 x 19 Classification					
¼″	.55	.51	.49	.41	.38	.37

TABLE G–4—RATED CAPACITIES FOR IMPROVED PLOW STEEL, FIBER CORE, WIRE ROPE AND WIRE ROPE SLINGS—Continued

[in tons of 2,000 pounds]

Rope diameter	Single leg					
	Vertical			Choker		
	A	B	C	A	B	C
3/8″	1.2	1.1	1.1	.91	.85	.80
1/2″	2.1	2.0	1.8	1.6	1.5	1.4
5/8″	3.3	3.1	2.8	2.5	2.3	2.1
3/4″	4.8	4.4	3.9	3.6	3.3	2.9
7/8″	6.4	5.9	5.1	4.8	4.5	3.9
1″	8.4	7.7	6.7	6.3	5.8	5.0
1 1/8″	10	9.5	8.4	7.9	7.1	6.3
	6 x 37 Classification					
1 1/4″	12	11	9.8	9.2	8.3	7.4
1 3/8″	15	13	12	11	10	8.9
1 1/2″	17	16	14	13	12	10
1 3/4″	24	21	19	18	16	14
2″	31	28	25	23	21	18

(A)—Socket or Swaged Terminal attachment.
(B)—Mechanical Sleeve attachment.
(C)—Hand Tucked Splice attachment.

TABLE G–5—RATED CAPACITIES FOR IMPROVED PLOW STEEL, FIBER CORE, WIRE ROPE SLINGS

[In tons of 2,000 pounds]

Rope diameter	Two-leg bridle or basket hitch											
	Vertical			60° bridle			45° bridle			30° bridle		
	A	B	C	A	B	C	A	B	C	A	B	C
	6 × 19 Classification											
1/4″	1.1	1.0	.99	.95	.88	.85	.77	.72	.70	.55	.51	.49
3/8″	2.4	2.2	2.1	2.1	1.9	1.8	1.7	1.6	1.5	1.2	1.1	1.1
1/2″	4.3	3.9	3.7	3.7	3.4	3.2	3.0	2.8	2.6	2.1	2.0	1.8
5/8″	6.7	6.2	5.6	5.8	5.3	4.8	4.7	4.4	4.0	3.3	3.1	2.8
3/4″	9.5	8.8	7.8	8.2	7.6	6.8	6.7	6.2	5.5	4.8	4.4	3.9
7/8″	13	12	10	11	10	8.9	9.1	8.4	7.3	6.4	5.9	5.1
1″	17	15	13	14	13	11	12	11	9.4	8.4	7.7	6.7
1 1/8″	21	19	17	18	16	14	15	13	12	10	9.5	8.4
	6 × 37 Classification											
1 1/4″	25	22	20	21	19	17	17	16	14	12	11	9.8
1 3/8″	30	27	24	26	23	20	21	19	17	15	13	12
1 1/2″	35	32	28	30	27	24	25	22	20	17	16	14
1 3/4″	48	43	38	41	37	33	34	30	27	24	21	19
2″	62	55	49	53	48	43	43	39	35	31	28	25

(A)—Socket or Swaged Terminal attachment.
(B)—Mechanical Sleeve attachment.
(C)—Hand Tucked Splice attachment.

TABLE G–6—NUMBER AND SPACING OF U-BOLT WIRE ROPE CLIPS

Improved plow steel, rope diameter, inches	Number of clips		Minimum spacing, inches
	Drop forged	Other material	
(1)	.....	.....	.....
1/2	3	4	3
5/8	3	4	3 3/4
3/4	4	5	4 1/2
7/8	4	5	5 1/4
1	4	6	6
1 1/8	5	6	6 3/4

TABLE G–6—NUMBER AND SPACING OF U-BOLT WIRE ROPE CLIPS—Continued

Improved plow steel, rope diameter, inches	Number of clips		Minimum spacing, inches
	Drop forged	Other material	
1 1/4	5	7	7 1/2
1 3/8	6	7	8 1/4
1 1/2	6	8	9

[1] Three clips shall be used on wire size less than 1/2-inch diameter.

TABLE G–7—WROUGHT IRON CHAIN

[In pounds or tons of 2,000 pounds]

Nominal size chains stock	Single leg	60° bridle	45° bridle	30° bridle
¼″ [1]	1060	1835	1500	1060
5/16″ [1]	1655	2865	2340	1655
⅜″ [1]	2385	2.1	3370	2385
7/16″ [1]	3250	2.8	2.3	3250
½″	2.1	3.7	3.0	2.1
9/16″ [1]	2.7	4.6	3.8	2.7
⅝″	3.3	5.7	4.7	3.3
¾″	4.8	8.3	6.7	4.8
⅞″	6.5	11.2	9.2	6.5
1″	8.5	14.7	12.0	8.5
1⅛″	10.0	17.3	14.2	10.0
1¼″	12.4	21.4	17.5	12.4
1⅜″	15.0	25.9	21.1	15.0
1½″	17.8	30.8	25.2	17.8
1⅝″	20.9	36.2	29.5	20.9
1¾″	24.2	42.0	34.3	24.2
1⅞″	27,6	47.9	39.1	27.6
2″	31.6	54.8	44.8	31.6

[1] These sizes of wrought iron chain are no longer manufactured in the United States.

TABLE G–8—ALLOY STEEL CHAIN

(In tons of 2,000 pounds)

Nominal size chain stock	Single leg	60° bridle	45° bridle	30° bridle
¼″	1.62	2.82	2.27	1.62
⅜″	3.30	5.70	4.65	3.30
½″	5.62	9.75	7.90	5.62
⅝″	8.25	14.25	11.65	8.25
¾″	11.5	19.9	16.2	11.5
⅞″	14.3	24.9	20.3	14.3
1″	19.3	33.5	27.3	19.8
1⅛″	22.2	38.5	31.5	22.2
1¼″	28.7	49.7	40.5	28.7
1⅜″	33.5	58.0	47.0	33.5
1½″	39.7	68.5	56.0	39.7
1⅝″	42.5	73.5	59.5	42.5
1¾″	47.0	81.5	62.0	47.0

TABLE G–9—MAXIMUM ALLOWABLE WEAR AT ANY POINT OF LINK

Chain size in inches	Maximum allowable wear in fraction of inches
¼(9/32)	3/64
⅜	5/64
½	7/64
⅝	9/64
¾	5/32
⅞	11/64
1	3/16
1⅛	7/32
1¼	¼
1⅜	9/32
1½	5/16
1¾	11/32

TABLE G–10—SAFE WORKING LOADS FOR SHACKLES

[In tons of 2,000 pounds]

Material size (inches)	Pin diameter (inches)	Safe working load
½	⅝	1.4
⅝	¾	2.2
¾	⅞	3.2
⅞	1	4.3
1	1⅛	5.6
1⅛	1¼	6.7
1¼	1⅜	8.2
1⅜	1½	10.0
1½	1⅝	11.9
1¾	2	16.2
2	2¼	21.2

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.120 Powered industrial truck operator training.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.178(l) of this chapter.

[63 FR 66274, Dec. 1, 1998]

Subpart H—Tools and Related Equipment

§ 1915.131 General precautions.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Hand lines, slings, tackles of adequate strength, or carriers such as tool bags with shoulder straps shall be provided and used to handle tools, materials, and equipment so that employees will have their hands free when using ship's ladders and access ladders. The use of hose or electric cords for this purpose is prohibited.

(b) When air tools of the reciprocating type are not in use, the dies and tools shall be removed.

(c) All portable, power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum are required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum are required to allow proper retraction and contact with the work. When the tool is withdrawn from

the work, the lower guard shall automatically and instantly return to the covering position.

(d) The moving parts of machinery on dry dock shall be guarded.

(e) Before use, pneumatic tools shall be secured to the extension hose or whip by some positive means to prevent the tool from becoming accidentally disconnected from the whip.

(f) The moving parts of drive mechanisms, such as gearing and belting on large portable tools, shall be adequately guarded.

(g) Headers, manifolds and widely spaced hose connection on compressed air lines shall bear the work ''air'' in letters at least 1 inch high, which shall be painted either on the manifold or separate hose connections, or on signs permanently attached to the manifolds or connections. Grouped air connections may be marked in one location.

(h) Before use, compressed air hose shall be examined. Visibly damaged and unsafe hose shall not be used.

§ 1915.132 Portable electric tools.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking except that paragraph (e) of this section applies to ship repairing only.

(a) The frames of portable electric tools and appliances, except double insulated tools approved by Underwriters' Laboratories, shall be grounded either through a third wire in the cable containing the circuit conductors or through a separate wire which is grounded at the source of the current.

(b) Grounding circuits, other than by means of the structure of the vessel on which the tool is being used, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance which is low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.

(c) Portable electric tools which are held in the hand shall be equipped with switches of a type which must be manually held in the closed position.

(d) Worn or frayed electric cables shall not be used.

(e) The employer shall notify the officer in charge of the vessel before using electric power tools operated with the vessel's current.

§ 1915.133 Hand tools.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Employers shall not issue or permit the use of unsafe hand tools.

(b) Wrenches, including crescent, pipe, end and socket wrenches, shall not be used when jaws are sprung to the point that slippage occurs.

(c) Impact tools, such as drift pins, wedges, and chisels, shall be kept free of mushroomed heads.

(d) The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight in the tool.

§ 1915.134 Abrasive wheels.

This section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) Floor stand and bench mounted abrasive wheels used for external grinding shall be provided with safety guards (protection hoods). The maximum angular exposure of the grinding wheel periphery and sides shall be not more than 90 degrees, except that when work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 125 degrees. In either case the exposure shall begin not more than 65 degrees above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the effect of a bursting wheel.

(b) Floor and bench mounted grinders shall be provided with work rests which are rigidly supported and readily adjustable. Such work rests shall be kept a distance not to exceed ⅛ inch from the surface of the wheel.

(c) Cup type wheels used for external grinding shall be protected by either a revolving cup guard or a band type guard in accordance with the provisions of the United States of America Standard Safety Code for the Use, Care, and Protection of Abrasive Wheels, B7.1. All other portable abrasive wheels used for external grinding shall be provided with safety guards (protection hoods) meeting the requirements of paragraph (e) of this section, except as follows:

(1) When the work location makes it impossible, in which case a wheel equipped with safety flanges as described in paragraph (f) of this section shall be used.

(2) When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used.

(d) Portable abrasive wheels used for internal grinding shall be provided with safety flanges (protection flanges) meeting the requirements of paragraph (f) of this section, except as follows:

(1) When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used.

(2) If the wheel is entirely within the work being ground while in use.

(e) When safety guards are required, they shall be so mounted as to maintain proper alignment with the wheel, and the guard and its fastenings shall be of sufficient strength to retain fragments of the wheel in case of accidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 180 degrees.

(f) When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges of a type and design and properly assembled so as to insure that the pieces of the wheel will be retained in case of accidental breakage shall be used.

(g) All abrasive wheels shall be closely inspected and ring tested before mounting to ensure that they are free from cracks or defects.

(h) Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place.

(i) The power supply shall be sufficient to maintain the rated spindle speed under all conditions of normal grinding. The rated maximum speed of the wheel shall not be exceeded.

(j) All employees using abrasive wheels shall be protected by eye protection equipment in accordance with the requirements of subpart I of this part except when adequate eye protection is afforded by eye shields which are permanently attached to the bench or floor stand.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.135 Powder actuated fastening tools.

(a) The section shall apply to ship repairing and shipbuilding only.

(b) *General precautions.* (1) Powder actuated fastening tools shall be tested each day before loading to ensure that the safety devices are in proper working condition. Any tool found not to be in proper working order shall be immediately removed from service until repairs are made.

(2) Powder actuated fastening tools shall not be used in an explosive or flammable atmosphere.

(3) All tools shall be used with the type of shield or muzzle guard appropriate for a particular use.

(4) Fasteners shall not be driven into very hard or brittle materials such as cast iron, glazed tile, surface hardened steel, glass block, live rock, face brick or hollow title.

(5) Fasteners shall not be driven into soft materials unless such materials are backed by a substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the opposite side.

(6) Unless a special guard, fixture or jig is used, fasteners shall not be driven directly into materials such as brick or concrete within 3 inches of the unsupported edge or corner, or into steel surfaces within ½ inch of the unsupported edge or corner. When fastening other material, such as 2 x 4 inch lumber to a concrete surface, fasteners of greater than 7/32 inch shank diameter shall not be used and fasteners shall not be driven within 2 inches of the unsupported edge or corner of the work surface.

(7) Fasteners shall not be driven through existing holes unless a positive guide is used to secure accurate alignment.

(8) No attempt shall be made to drive a fastener into a spalled area caused by an unsatisfactory fastening.

(9) Employees using powder actuated fastening tools shall be protected by personal protective equipment in accordance with the requirements of subpart I of this part.

(c) *Instruction of operators.* Before employees are permitted to use powder actuated tools, they shall have been thoroughly instructed by a competent person with respect to the requirements of paragraph (b) of this section and the safe use of such tools as follows:

(1) Before using a tool, the operator shall inspect it to determine that it is clean, that all moving parts operate freely and that the barrel is free from obstructions.

(2) When a tool develops a defect during use, the operator shall immediately cease to use it and shall notify his supervisor.

(3) Tools shall not be loaded until just prior to the intended firing time and the tool shall not be left unattended while loaded.

(4) The tool, whether loaded or empty, shall not be pointed at any person, and hands shall be kept clear of the open barrel end.

(5) In case of a misfire, the operator shall hold the tool in the operating position for at least 15 seconds and shall continue to hold the muzzle against the work surface during disassembly or opening of the tool and removal of the powder load.

(6) Neither tools nor powder charges shall be left unattended in places where they would be available to unauthorized persons.

[47 FR 16986, Apr. 20, 1982, as amended at 61 FR 26351, May 24, 1996]

§ 1915.136 Internal combustion engines, other than ship's equipment.

The provisions of this section shall apply to ship repairing, shipbuilding and shipbreaking.

(a) When internal combustion engines furnished by the employer are used in a fixed position below decks, for such purposes as driving pumps, generators, and blowers, the exhaust shall be led to the open air, clear of any ventilation intakes and openings through which it might enter the vessel.

(b) All exhaust line joints and connections shall be checked for tightness immediately upon starting the engine, and any leaks shall be corrected at once.

(c) When internal combustion engines on vehicles, such as forklifts and mobile cranes, or on portable equipment such as fans, generators, and pumps exhaust into the atmosphere below decks, the competent person shall make tests of the carbon monoxide content of the atmosphere as frequently as conditions require to ensure that dangerous concentrations do not develop. Employees shall be removed from the compartment involved when the carbon monoxide concentration exceeds 50 parts per million (0.005%). The employer shall use blowers sufficient in size and number and so arranged as to maintain the concentration below this allowable limit before work is resumed.

Subpart I—Personal Protective Equipment (PPE)

SOURCE: 61 FR 26352, May 24, 1996, unless otherwise noted.

§ 1915.151 Scope, application and definitions.

(a) *Scope and application.* This subpart applies to all work in shipyard employment regardless of geographic location.

(b) *Definitions applicable to this subpart.*

Anchorage means a secure point of attachment for lifelines, lanyards, or deceleration devices.

Body belt means a strap with means for both securing it about the waist and attaching it to a lanyard, lifeline, or deceleration device.

Body harness means straps which may be secured about the employee in a manner that will distribute the fall arrest forces over at least the thighs, shoulders, chest and pelvis with means for attaching it to other components of a personal fall arrest system.

Connector means a device which is used to couple (connect) parts of a personal fall arrest system or parts of a positioning device system together. It may be an independent component of the system, such as a carabiner, or it may be an integral component of part of the system (such as a buckle or D-ring sewn into a body belt or body harness or a snaphook spliced or sewn to a lanyard or self-retracting lanyard).

Deceleration device means any mechanism, such as a rope grab, ripstitch

lanyard, specially woven lanyard, tearing or deforming lanyard, or automatic self-retracting lifeline/lanyard, which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

Deceleration distance means the additional vertical distance a falling employee travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of an employee's body belt or body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall, and the location of that attachment point after the employee comes to a full stop.

Equivalent means alternative designs, materials, or methods to protect against a hazard which the employer can demonstrate will provide an equal or greater degree of safety for employees than the method or item specified in the standard.

Free fall means the act of falling before a personal fall arrest system begins to apply force to arrest the fall.

Free fall distance means the vertical displacement of the fall arrest attachment point on the employee's body belt or body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance, and lifeline/lanyard elongation, but includes any deceleration device slide distance or self-retracting lifeline/lanyard extension before the device operates and fall arrest forces occur.

Lanyard means a flexible line of rope, wire rope, or strap which generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.

Lifeline means a component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

Lower levels means those areas or surfaces to which an employee can fall. Such areas or surfaces include but are not limited to ground levels, floors, ramps, tanks, materials, water, excavations, pits, vessels, structures, or portions thereof.

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, body belt or body harness and may include a lanyard, a deceleration device, a lifeline, or a suitable combination of these. As of January 1, 1998, the use of a body belt for fall arrest is prohibited.

Positioning device system means a body belt or body harness system rigged to allow an employee to be supported at an elevated vertical surface, such as a wall or window, and to be able to work with both hands free while leaning.

Qualified person means a person who by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems related to the subject matter and work.

Restraint (tether) line means a line from an anchorage, or between anchorages, to which the employee is secured in such a way as to prevent the employee from walking or falling off an elevated work surface. Note: A restraint line is not necessarily designed to withstand forces resulting from a fall.

Rope grab means a deceleration device which travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee. A rope grab usually employs the principle of inertial locking, cam/level locking or both.

§ 1915.152 General requirements.

(a) *Provision and use of equipment.* The employer shall provide and shall ensure that each affected employee uses the appropriate personal protective equipment (PPE) for the eyes, face, head, extremities, torso, and respiratory system, including protective clothing, protective shields, protective barriers, personal fall protection equipment, and

life saving equipment, meeting the applicable provisions of this subpart, wherever employees are exposed to work activity hazards that require the use of PPE.

(b) *Hazard assessment and equipment.* The employer shall assess its work activity to determine whether there are hazards present, or likely to be present, which necessitate the employee's use of PPE. If such hazards are present, or likely to be present, the employer shall:

(1) Select the type of PPE that will protect the affected employee from the hazards identified in the occupational hazard assessment;

(2) Communicate selection decisions to affected employees;

(3) Select PPE that properly fits each affected employee; and

(4) Verify that the required occupational hazard assessment has been performed through a document that contains the following information: occupation, the date(s) of the hazard assessment, and the name of the person performing the hazard assessment.

NOTE 1 TO PARAGRAPH (b): A hazard assessment conducted according to the trade or occupation of affected employees will be considered to comply with paragraph (b) of this section, if the assessment addresses any PPE-related hazards to which employees are exposed in the course of their work activities.

NOTE 2 TO PARAGRAPH (b): Non-mandatory appendix A to this subpart contains examples of procedures that will comply with the requirement for an occupational hazard assessment.

(c) *Defective and damaged equipment.* Defective or damaged PPE shall not be used.

(d) *Reissued equipment.* The employer shall ensure that all unsanitary PPE, including that which has been used by employees, be cleaned and disinfected before it is reissued.

(e) *Training.* (1) The employer shall provide training to each employee who is required, by this section, to use PPE (exception: training in the use of personal fall arrest systems and positioning device systems training is covered in §§1915.159 and 1915.160). Each employee shall be trained to understand at least the following:

(i) When PPE is necessary;

(ii) What PPE is necessary;

(iii) How to properly don, doff, adjust, and wear PPE;

(iv) The limitations of the PPE; and,

(v) The proper care, maintenance, useful life and disposal of the PPE.

(2) The employer shall ensure that each effected employee demonstrates the ability to use PPE properly before being allowed to perform work requiring the use of PPE.

(3) The employer shall retrain any employee who does not understand or display the skills required by paragraph (e)(2) of this section. Circumstances where retraining is required include, but are not limited to, situations where:

(i) Changes in occupation or work render previous training obsolete; or

(ii) Changes in the types of PPE to be used render previous training obsolete; or

(iii) Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

(4) The employer shall verify that each affected employee has received the required training through a document that contains the following information: name of each employee trained, the date(s) of training, and type of training the employee received.

[61 FR 26352, May 24, 1996; 61 FR 29957, June 13, 1996]

§ 1915.153 Eye and face protection.

(a) *General requirements.* (1) The employer shall ensure that each affected employee uses appropriate eye or face protection where there are exposures to eye or face hazards caused by flying particles, molten metal, liquid chemicals, acid or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

(2) The employer shall ensure that each affected employee uses eye or face protection that provides side protection when there is a hazard from flying objects. Detachable side protectors (e.g., a clip-on or slide-on side shield) meeting the pertinent requirements of this section are acceptable.

(3) The employer shall ensure that each affected employee who wears prescription lenses while engaged in operations that involve eye hazards wears

eye protection that incorporates the prescription in its design, unless the employee is protected by eye protection that can be worn over prescription lenses without disturbing the proper position of either the PPE or the prescription lenses.

(4) The employer shall ensure that each affected employee uses equipment with filter lenses that have a shade number that provides appropriate protection from injurious light radiation. Table I–1 is a listing of appropriate shade numbers for various operations. If filter lenses are used in goggles worn under a helmet which has a lens, the shade number of the lens in the helmet may be reduced so that the shade numbers of the two lenses will equal the value as shown in Table I–1, § 1915.153.

TABLE I–1—FILTER LENSES FOR PROTECTION AGAINST RADIANT ENERGY

Operations	Electrode size 1/32 in.	Arc current	Minimum protective shade
Shielded metal arc welding	Less than 3	Less than	7
	3–5	60	8
	5–8	60–160	10
	More than 8	160–250	11
		250–550	
Gas metal arc welding and flux cored arc welding.		Less than	7
		60	10
		60–160	10
		160–250	10
		250–500	
Gas Tungsten arc welding		Less than	8
		50	8
		50–150	10
		150–500	
Air carbon	(Light)	Less than	10
Arc cutting	(Heavy)	500	11
		500–1000	
Plasma arc welding		Less than	6
		20	8
		20–	10
		100	11
		100–	
		400	
		400–	
		800	
Plasma arc cutting	(light)**	Less than 300	8
	(medium)**	300–400	9
	(heavy)**	400–800	10
Torch brazing			3
Torch soldering			2
Carbon Arc welding			14

** These values apply where the actual arc is clearly seen. Lighter filters may be used when the arc is hidden by the workpiece.

FILTER LENSES FOR PROTECTION AGAINST RADIANT ENERGY

Operations	Plate thickness— inches	Plate thickness— mm	Minimum* protective shade
Gas welding:			
Light	Under 1/8	Under 3.2	4
Medium	1/8 to 1/2	3.2 to 12.7	5
Heavy	Over 1/2	Over 12.7	6
Oxygen cutting			
Light	Under 1	Under 25	3
Medium	1 to 6	25 to 150	4
Heavy	Over 6	Over 150	5

* As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

(b) *Criteria for protective eye and face devices.* (1) Protective eye and face devices purchased after May 20, 1982, shall comply with the American National Standards Institute, ANSI Z87.1–1989, ''Practice for Occupational and Educational Eye and Face Protection,'' which is incorporated by reference as specified in § 1915.5, or shall be demonstrated by the employer to be equally effective.

(2) Eye and face protective devices purchased before May 20, 1982, shall comply with ''American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1 –1979,'' which is incorporated by reference as specified in § 1915.5, or shall be demonstrated by the employer to be equally effective.

§ 1915.154 Respiratory protection.

Respiratory protection for shipyard employment is covered by 29 CFR 1910.134.

§ 1915.155 Head protection.

(a) *Use.* (1) The employer shall ensure that each affected employee wears a protective helmet when working in areas where there is a potential for injury to the head from falling objects.

(2) The employer shall ensure that each affected employee wears a protective helmet designed to reduce electrical shock hazards where there is potential for electric shock or burns due to contact with exposed electrical conductors which could contact the head.

(b) *Criteria for protective helmets.* (1) Protective helmets purchased after August 22, 1996, shall comply with ANSI Z89.1–1986, ''Personnel Protection—Protective Headwear for Industrial Workers-Requirements,'' which is incorporated by reference, as specified in § 1915.5, or shall be demonstrated by the employer to be equally effective.

(2) Protective helmets purchased before August 22, 1996, shall comply with the ''American National Standard Safety Requirements for Industrial Head Protection, Z89.1–1969,'' which is incorporated by reference as specified in 1915.5, or shall be demonstrated by the employer to be equally effective.

§ 1915.156 Foot protection.

(a) *Use.* The employer shall ensure that each affected employee wears protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects or objects piercing the sole.

(b) *Criteria for protective footwear.* (1) Protective footwear purchased after August 22, 1996, shall comply with ANSI Z41–1991, ''American National Standard for Personal Protection-Protective Footwear,'' which is incorporated by reference, as specified in § 1915.5, or shall be demonstrated by the employer to be equally as effective.

(2) Protective footwear purchased before August 22, 1996, shall comply with the ''American National Standard for Personal Protection- Protective Footwear Z41–1983,'' which is incorporated by reference, as specified in § 1915.5, or shall be demonstrated by the employer to be equally effective.

§ 1915.157 Hand and body protection.

(a) *Use.* The employer shall ensure that each affected employee uses appropriate hand protection and other protective clothing where there is exposure to hazards such as skin absorption of harmful substances, severe cuts or lacerations, severe abrasions, punctures, chemical burns, thermal burns, harmful temperature extremes, and sharp objects.

(b) *Hot work operations.* The employer shall ensure that no employee wears clothing impregnated or covered in full or in part with flammable or combustible materials (such as grease or oil) while engaged in hot work operations or working near an ignition source.

(c) *Electrical protective devices.* The employer shall ensure that each affected employee wears protective electrical insulating gloves and sleeves or other electrical protective equipment, if that employee is exposed to electrical shock hazards while working on electrical equipment.

§ 1915.158 Lifesaving equipment.

(a) *Personal flotation devices.* (1) Personal flotation devices (PFD) (life preservers, life jackets and work vests) worn by each affected employee shall be any United States Coast Guard (USCG) approved and marked Type I

PFD, Type II PFD, or Type III PFD; or PFDs shall be a USCG approved Type V PFD which is marked for use as a work vest, for commercial use, or for use on vessels. USCG approval is pursuant to 46 CFR part 160, subpart Q, Coast Guard Lifesaving Equipment Specifications.

(2) Prior to each use, personal floatation devices shall be inspected for dry rot, chemical damage, or other defects which may affect their strength and buoyancy. Defective personal floatation devices shall not be used.

(b) *Ring life buoys and ladders.* (1) When work is being performed on a floating vessel 200 feet (61 m) or more in length, at least three 30-inch (0.76 m) U.S. Coast Guard approved ring life buoys with lines attached shall be located in readily visible and accessible places. Ring life buoys shall be located one forward, one aft, and one at the access to the gangway.

(2) On floating vessels under 200 feet (61 m) in length, at least one 30-inch (0.76 m) U.S. Coast Guard approved ring life buoy with line attached shall be located at the gangway.

(3) At least one 30-inch (0.76 m) U. S. Coast Guard approved ring life buoy with a line attached shall be located on each staging alongside of a floating vessel on which work is being performed.

(4) At least 90 feet (27 m) of line shall be attached to each ring life buoy.

(5) There shall be at least one portable or permanent ladder in the vicinity of each floating vessel on which work is being performed. The ladder shall be of sufficient length to assist employees to reach safety in the event they fall into the water.

§ 1915.159 Personal fall arrest systems (PFAS).

The criteria of this section apply to PFAS and their use. Effective January 1, 1998, body belts and non-locking snaphooks are not acceptable as part of a personal fall arrest system.

(a) *Criteria for connectors and anchorages.* (1) Connectors shall be made of drop forged, pressed, or formed steel or shall be made of materials with equivalent strength.

(2) Connectors shall have a corrosion-resistant finish, and all surfaces and edges shall be smooth to prevent damage to the interfacing parts of the system.

(3) D-rings and snaphooks shall be capable of sustaining a minimum tensile load of 5,000 pounds (22.2 Kn).

(4) D-rings and snaphooks shall be proof-tested to a minimum tensile load of 3,600 pounds (16 Kn) without cracking, breaking, or being permanently deformed.

(5) Snaphooks shall be sized to be compatible with the member to which they are connected to prevent unintentional disengagement of the snaphook caused by depression of the snaphook keeper by the connected member, or shall be of a locking type that is designed and used to prevent disengagement of the snap-hook by contact of the snaphook keeper by the connected member.

(6) Snaphooks, unless of a locking type designed and used to prevent disengagement from the following connections, shall not be engaged:

(i) Directly to webbing, rope or wire rope;

(ii) To each other;

(iii) To a D-ring to which another snaphook or other connector is attached;

(iv) To a horizontal lifeline; or

(v) To any object that is incompatibly shaped or dimensioned in relation to the snaphook such that unintentional disengagement could occur by the connected object being able to depress the snaphook keeper and release itself.

(7) On suspended scaffolds or similar work platforms with horizontal lifelines that may become vertical lifelines, the devices used for connection to the horizontal lifeline shall be capable of locking in any direction on the lifeline.

(8) Anchorages used for attachment of personal fall arrest equipment shall be independent of any anchorage being used to support or suspend platforms.

(9) Anchorages shall be capable of supporting at least 5,000 pounds (22.2 Kn) per employee attached, or shall be designed, installed, and used as follows:

(i) As part of a complete personal fall arrest system which maintains a safety factor of at least two; and

(ii) Under the direction and supervision of a qualified person.

(b) *Criteria for lifelines, lanyards, and personal fall arrest systems.* (1) When vertical lifelines are used, each employee shall be provided with a separate lifeline.

(2) Vertical lifelines and lanyards shall have a minimum tensile strength of 5,000 pounds (22.2 Kn).

(3) Self-retracting lifelines and lanyards that automatically limit free fall distances to 2 feet (0.61 m) or less shall be capable of sustaining a minimum tensile load of 3000 pounds (13.3 Kn) applied to a self-retracting lifeline or lanyard with the lifeline or lanyard in the fully extended position.

(4) Self-retracting lifelines and lanyards which do not limit free fall distance to 2 feet (0.61 m) or less, ripstitch lanyards and tearing and deforming lanyards shall be capable of sustaining a minimum static tensile load of 5,000 pounds (22.2 Kn) applied to the device when they are in the fully extended position.

(5) Horizontal lifelines shall be designed, installed, and used under the supervision of a qualified person, and shall only be used as part of a complete personal fall arrest system that maintains a safety factor of at least two.

(6) Effective November 20, 1996, personal fall arrest systems shall:

(i) Limit the maximum arresting force on a falling employee to 900 pounds (4 Kn) when used with a body belt;

(ii) Limit the maximum arresting force on a falling employee to 1,800 pounds (8 Kn) when used with a body harness;

(iii) Bring a falling employee to a complete stop and limit the maximum deceleration distance an employee travels to 3.5 feet (1.07 m), and

(iv) Have sufficient strength to withstand twice the potential impact energy of an employee free falling a distance of 6 feet (1.8 m), or the free fall distance permitted by the system, whichever is less;

NOTE TO PARAGRAPH (b)(6) OF THIS SECTION: A personal fall arrest system which meets the criteria and protocols contained in appendix B, is considered to comply with paragraph (b)(6). If the combined tool and body weight is 310 pounds (140 kg) or more, systems that meet the criteria and protocols contained in appendix B will be deemed to comply with the provisions of paragraphs (b)(6) only if they are modified appropriately to provide protection for the extra weight of the employee and tools.

(7) Personal fall arrest systems shall be rigged such that an employee can neither free fall more than 6 feet (1.8 m) nor contact any lower level.

(c) *Criteria for selection, use and care of systems and system components.* (1) Lanyards shall be attached to employees using personal fall arrest systems, as follows:

(i) The attachment point of a body harness shall be located in the center of the wearer's back near the shoulder level, or above the wearer's head. If the free fall distance is limited to less than 20 inches, the attachment point may be located in the chest position; and

(ii) The attachment point of a body belt shall be located in the center of the wearer's back.

(2) Ropes and straps (webbing) used in lanyards, lifelines and strength components of body belts and body harnesses shall be made from synthetic fibers or wire rope.

(3) Ropes, belts, harnesses, and lanyards shall be compatible with their hardware.

(4) Lifelines and lanyards shall be protected against cuts, abrasions, burns from hot work operations and deterioration by acids, solvents, and other chemicals.

(5) Personal fall arrest systems shall be inspected prior to each use for mildew, wear, damage, and other deterioration. Defective components shall be removed from service.

(6) Personal fall arrest systems and components subjected to impact loading shall be immediately removed from service and shall not be used again for employee protection until inspected and determined by a qualified person to be undamaged and suitable for reuse.

(7) The employer shall provide for prompt rescue of employees in the event of a fall or shall ensure that employees are able to rescue themselves.

(8) Body belts shall be at least one and five eighths inches (4.1 cm) wide.

(9) Personal fall arrest systems and components shall be used only for employee fall protection and not to hoist materials.

(d) *Training*. Before using personal fall arrest equipment, each affected employee shall be trained to understand the application limits of the equipment and proper hook-up, anchoring, and tie-off techniques. Affected employees shall also be trained so that they can demonstrate the proper use, inspection, and storage of their equipment.

§ 1915.160 Positioning device systems.

Positioning device systems and their use shall conform to the following provisions:

(a) *Criteria for connectors and anchorages*. (1) Connectors shall have a corrosion-resistant finish, and all surfaces and edges shall be smooth to prevent damage to interfacing parts of this system.

(2) Connecting assemblies shall have a minimum tensile strength of 5,000 pounds (22.2 Kn).

(3) Positioning device systems shall be secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall.

(4) Snaphooks, unless each is of a locking type designed and used to prevent disengagement, shall not be connected to each other. As of January 1, 1998, only locking type snaphooks shall be used in positioning device systems.

(b) *Criteria for positioning device systems*. (1) Restraint (tether) lines shall have a minimum breaking strength of 3,000 pounds (13.3 Kn).

(2) The following system performance criteria for positioning device systems are effective November 20, 1996:

(i) A window cleaner's positioning system shall be capable of withstanding without failure a drop test consisting of a 6 foot (1.83 m) drop of a 250 pound (113 kg) weight. The system shall limit the initial arresting force to not more than 2,000 pounds (8.89 Kn), with a duration not to exceed 2 milliseconds. The system shall limit any subsequent arresting forces imposed on the falling employee to not more than 1,000 pounds (4.45 Kn);

(ii) All other positioning device systems shall be capable of withstanding without failure a drop test consisting of a 4- foot (1.2 m) drop of a 250-pound (113 kg) weight.

NOTE TO PARAGRAPH (b)(2) OF THIS SECTION: Positioning device systems which comply with the provisions of section 2 of non-mandatory appendix B to this subpart shall be deemed to meet the requirements of this paragraph (b)(2).

(c) *Criteria for the use and care of positioning device systems*. (1) Positioning device systems shall be inspected before each use for mildew, wear, damage, and other deterioration. Defective components shall be removed from service.

(2) A positioning device system or component subjected to impact loading shall be immediately removed from service and shall not be used again for employee protection, unless inspected and determined by a qualified person to be undamaged and suitable for reuse.

(d) *Training*. Before using a positioning device system, employees shall be trained in the application limits, proper hook-up, anchoring and tie-off techniques, methods of use, inspection, and storage of positioning device systems.

APPENDIX A TO SUBPART I OF PART 1915—NON-MANDATORY GUIDELINES FOR HAZARD ASSESSMENT, PERSONAL PROTECTIVE EQUIPMENT (PPE) SELECTION, AND PPE TRAINING PROGRAM

This appendix is intended to provide compliance assistance for hazard assessment, selection of personal protective equipment (PPE) and PPE training. It neither adds to or detracts from the employer's responsibility to comply with the provisions of this subpart.

1. Controlling hazards. Employers and employees should not rely exclusively on PPE for protection from hazards. PPE should be used, where appropriate, in conjunction with engineering controls, guards, and safe work practices and procedures.

2. Assessment and selection. Employers need to consider certain general guidelines for assessing the hazardous situations that are likely to arise under foreseeable work activity conditions and to match employee PPE to the identified hazards. The employer should designate a safety officer or some other qualified person to exercise common sense and appropriate expertise to assess work activity hazards and select PPE.

3. Assessment guidelines. In order to assess the need for PPE the following steps should be taken:

a. Survey. Conduct a walk-through survey of the area in question to identify sources of hazards.

Categories for Consideration:

(1) Impact
(2) Penetration
(3) Compression (roll-over)
(4) Chemical
(5) Heat
(6) Harmful dust
(7) Light (optical) radiation
(8) Drowning
(9) Falling

b. *Sources*. During the walk-through survey the safety officer should observe:

(1) Sources of motion; for example, machinery or processes where any movement of tools, machine elements or particles could exist, or movement of personnel that could result in collision with stationary objects.

(2) Sources of high temperatures that could result in burns, eye injury or ignition of protective equipment.

(3) Types of chemical exposures.

(4) Sources of harmful dust.

(5) Sources of light radiation, for instance, welding, brazing, cutting, heat treating, furnaces, and high intensity lights.

(6) Sources of falling objects or potential for dropping objects.

(7) Sources of sharp objects which might pierce or cut the hands.

(8) Sources of rolling or pinching objects which could crush the feet.

(9) Layout of work place and location of co-workers.

(10) Any electrical hazards.

(11) Review injury/accident data to help identify problem areas.

Organize data. Following the walk-through survey, it is necessary to organize the data and other information obtained. That material provides the basis for hazard assessment that enables the employer to select the appropriate PPE.

d. *Analyze data*. Having gathered and organized data regarding a particular occupation, employers need to estimate the potential for injuries. Each of the identified hazards (see paragraph 3.a.) should be reviewed and classified as to its type, the level of risk, and the seriousness of any potential injury. Where it is foreseeable that an employee could be exposed to several hazards simultaneously, the consequences of such exposure should be considered.

4. *Selection guidelines*. After completion of the procedures in paragraph 3, the general procedure for selection of protective equipment is to:

(a) become familiar with the potential hazards and the types of protective equipment that are available, and what they can do; for example, splash protection, and impact protection;

(b) compare the hazards associated with the environment; for instance, impact velocities, masses, projectile shapes, radiation intensities, with the capabilities of the available protective equipment;

(c) select the protective equipment which ensures a level of protection greater than the minimum required to protect employees from the hazards; and

(d) fit the user with the protective device and give instructions on care and use of the PPE. It is very important that users be made aware of all warning labels and limitations of their PPE.

5. *Fitting the device*. Careful consideration must be given to comfort and fit. The employee will be most likely to wear the protective device if it fits comfortably. PPE that does not fit properly may not provide the necessary protection, and may create other problems for wearers. Generally, protective devices are available in a variety of sizes and choices. Therefore employers should be careful to select the appropriate sized PPE.

6. *Devices with adjustable features*. (a) Adjustments should be made on an individual basis so the wearer will have a comfortable fit that maintains the protective device in the proper position. Particular care should be taken in fitting devices for eye protection against dust and chemical splash to ensure that the seal is appropriate for the face.

(b) In addition, proper fitting of hard hats is important to ensure that the hard hat will not fall off during work operations. In some cases a chin strap may be necessary to keep the hard hat on an employee's head. (Chin straps should break at a reasonably low force to prevent a strangulation hazard). Where manufacturer's instructions are available, they should be followed carefully.

7. *Reassessment of hazards*. Compliance with the hazard assessment requirements of §1915.152(b) will involve the reassessment of work activities where changing circumstances make it necessary. a. The employer should have a safety officer or other qualified person reassess the hazards of the work activity area as necessary. This reassessment should take into account changes in the workplace or work practices, such as those associated with the installation of new equipment, and the lessons learned from reviewing accident records, and a reevaluation performed to determine the suitability of PPE selected for use.

8. *Selection chart guidelines for eye and face protection*. Examples of occupations for which eye protection should be routinely considered are carpenters, engineers, coppersmiths, instrument technicians, insulators, electricians, machinists, mobile equipment mechanics and repairers, plumbers and ship fitters, sheet metal workers and tinsmiths, grinding equipment operators, machine operators, welders, boiler workers, painters, laborers, grit blasters, ship fitters and burners. This is not a complete list of occupations that require the use of eye protection. The following chart provides general guidance for

the proper selection of eye and face protection to protect against hazards associated with the listed hazard ''source'' operations.

EYE AND FACE PROTECTION SELECTION CHART

Source	Assessment of hazard	Protection
Impact:		
Chipping, grinding machining, masonry work, woodworking, sawing, drilling, chiseling, powered fastening, riveting, and sanding.	Flying fragments, objects, large chips, particles, sand, dirt, etc.	Spectacles with side protection, goggles, face shields. See notes (1), (3), (5), (6), (10). For severe exposure, use face shield.
Heat:		
Furnace operations, pouring, casting, hot dipping, and welding.	Hot sparks	Face shields, goggles, spectacles with side protection. For severe exposure use face shield. See notes (1), (2), (3).
	Splash from molten metals.	Face shields worn over goggles. See notes (1), (2), (3).
	High temperature exposure.	Screen face shields, reflective face shields. See notes (1), (2), (3).
Chemicals:		
Acid and chemicals handling, degreasing, plating.	Splash	Goggles, eyecup and cover types. For severe exposure, use face shield. See notes (3), (11).
	Irritating mists	Special-purpose goggles.
Dust:		
Woodworking, buffing, general dusty conditions.	Nuisance dust	Goggles, eyecup and cover types. See note (8).
Light and/or Radiation:		
Welding: Electric arc	Optical radiation	Welding helmets or welding shields. Typical shades: 10–14. See notes (9), (12).
Welding: Gas	Optical radiation	Welding goggles or welding face shield. Typical shades: gas welding 4–8, cutting 3–6, brazing 3–4. See note (9).
Cutting, Torch brazing, Torch soldering	Optical radiation	Spectacles or welding face-shield. Typical shades, 1.5–3. See notes (3), (9).
Glare	Poor vision	Spectacles with shaded or special-purpose lenses, as suitable. See notes (9), (10).

NOTES TO EYE AND FACE PROTECTION SELECTION CHART

(a) Care should be taken to recognize the possibility of multiple and simultaneous exposure to a variety of hazards. Adequate protection against the highest level of each of the hazards should be provided. Protective devices do not provide unlimited protection.

(b) Operations involving heat may also involve light radiation. As required by the standard, protection from both hazards must be provided.

(c) Face shields should only be worn over primary eye protection (spectacles or goggles).

(d) As required by the standard, filter lenses must meet the requirements for shade designations in §1915.153(a)(4). Tinted and shaded lenses are not filter lenses unless they are marked or identified as such.

(e) As required by the standard, persons whose vision requires the use of prescription (Rx) lenses must wear either protective devices fitted with prescription (Rx) lenses or protective devices designed to be worn over regular prescription (Rx) eye wear.

(f) Wearers of contact lenses must also wear appropriate eye and face protection devices in a hazardous environment. It should be recognized that dusty and/or chemical environments may represent an additional hazard to contact lens wearers.

(g) Caution should be exercised in the use of metal frame protective devices in electrical hazard areas.

(h) Atmospheric conditions and the restricted ventilation of the protector can cause lenses to fog. Frequent cleansing may be necessary.

(i) Welding helmets or face shields should be used only over primary eye protection (spectacles or goggles).

(j) Non-side shield spectacles are available for frontal protection only, but are not acceptable eye protection for the sources and operations listed for ''impact.''

(k) Ventilation should be adequate, but well protected from splash entry. Eye and face protection should be designed and used so that it provides both adequate ventilation and protects the wearer from splash entry.

(l) Protection from light radiation is directly related to filter lens density. See note (d). Select the darkest shade that allows task performance.

9. *Selection guidelines for head protection.* (a) Hard hats are designed to provide protection from impact and penetration hazards caused by falling objects. Head protection is also available which provides protection from electric shock and burn. When selecting head

protection, knowledge of potential electrical hazards is important. Class A helmets, in addition to impact and penetration resistance, provide electrical protection from low-voltage conductors. (They are proof tested to 2,200 volts.) Class B helmets, in addition to impact and penetration resistance, provide electrical protection from high-voltage conductors. (They are proof tested to 20,000 volts.) Class C helmets provide impact and penetration resistance. (They are usually made of aluminum, which conducts electricity and should not be used around electrical hazards.)

(b) Where falling object hazards are present, head protection must be worn. Some examples of exposure include: working below other workers who are using tools and materials which could fall; working around or under conveyor belts which are carrying parts or materials; working below machinery or processes which might cause material or objects to fall; and working on exposed energized conductors.

(c) Examples of occupations for which head protection should be considered are: carpenters, electricians, machinists, boilermakers, erectors, plumbers, coppersmiths, ship fitters, welders, laborers and material handlers.

10. *Selection guidelines for foot protection.* (a) Safety shoes and boots must meet ANSI Z41–1991 and provide impact and compression protection to the foot. Where necessary, safety shoes can be obtained which provide puncture protection. In some work situations, metatarsal protection should be provided, and in some other special situations electrical conductive or insulating safety shoes would be appropriate.

(b) Safety shoes or boots with impact protection would be required for carrying or handling materials such as packages, objects, parts or heavy tools, which could be dropped, and for other activities where objects might fall onto the feet. Safety shoes or boots with compression protection would be required for work activities involving skid trucks (manual material handling carts) around bulk rolls (such as paper rolls) and around heavy pipes, all of which could potentially roll over an employees' feet. Safety shoes or boots with puncture protection would be required where sharp objects such as nails, wire, tacks, screws, large staples, scrap metal etc., could be stepped on by employees, causing an injury.

(c) Some occupations (not a complete list) for which foot protection should be routinely considered are: shipping and receiving clerks, stock clerks, carpenters, electricians, machinists, boiler makers, plumbers, copper smiths, pipe fitters, ship fitters, burners, chippers and grinders, erectors, press operators, welders, laborers, and material handlers.

11. *Selection guidelines for hand protection.* (a) Gloves are often relied upon to prevent cuts, abrasions, burns, and skin contact with chemicals that are capable of causing local or systemic effects following dermal exposure. OSHA is unaware of any gloves that provide protection against all potential hand hazards, and commonly available glove materials provide only limited protection against many chemicals. Therefore, it is important to select the most appropriate glove for a particular application and to determine how long it can be worn, and whether it can be reused.

(b) It is also important to know the performance characteristics of gloves relative to the specific hazard anticipated, e.g., chemical hazards, cut hazards, and flame hazards. These performance characteristics should be assessed by using standard test procedures. Before purchasing gloves, the employer should request documentation from the manufacturer that the gloves meet the appropriate test standard(s) for the hazard(s) anticipated.

(c) other general factors to be considered for glove selection are:

(A) As long as the performance characteristics are acceptable, in certain circumstances, it may be more cost effective to regularly change cheaper gloves than to reuse more expensive types; and,

(B) The work activities of the employee should be studied to determine the degree of dexterity required, the duration, frequency, and degree of exposure to the hazard, and the physical stresses that will be applied.

(d) With respect to selection of gloves for protection against chemical hazards:

(A) The toxic properties of the chemical(s) must be determined; in particular, the ability of the chemical to cause local effects on the skin or to pass through the skin and cause systemic effects or both;

(B) Generally, any ''chemical resistant'' glove can be used for dry powders;

(C) For mixtures and formulated products (unless specific test data are available), a glove should be selected on the basis of the chemical component with the shortest breakthrough time, since it is possible for solvents to carry active ingredients through polymeric materials; and,

(D) Employees must be able to remove the gloves in such a manner as to prevent skin contamination.

12. *Cleaning and maintenance.* (a) It is important that all PPE be kept clean and be properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision.

(b) For the purposes of compliance, PPE should be inspected, cleaned, and maintained at regular intervals so that the PPE provides the requisite protection.

(c) It is important to ensure that contaminated PPE which cannot be decontaminated is disposed of in a manner that protects employees from exposure to hazards.

13. *Examples of work activities, trades and selection of basic PPE.*

Example 1:

the work activity area hazards to which welders are exposed, the equipment listed below is the basic PPE required for this occupation. This does not take into account a job location in which additional PPE may be required, such as where the welder works from an elevated platform without guard rails. In this situation the welder must also wear the proper fall protection equipment, such as a body harness.

—Hard hat
—Welding Shield (Face)
—Welding Gloves
—Safety Glasses
—Safety Shoes
—Welding Sleeves (welding in the overhead position)
(Signed and dated)

Example 2:

on an assessment of the workplace hazards to which shipyard maintenance workers are exposed, the equipment listed below is the basic PPE required for this occupation. Where maintenance workers are exposed to other hazards, such as asbestos, the insulation on a pipe is being repaired, maintenance workers must be provided with the appropriate supplemental PPE (requirements for asbestos PPE are set out in 1915.1001).

—Hard Hat
—Safety Glasses
—Work Gloves
—Safety Shoes
(Signed and Dated)

Example 3:

Based on an assessment of the workplace hazards to which shipyard chipper and grinder workers are exposed, the equipment listed below is the basic PPE required for this occupation. Where workers are exposed to other hazards, such as hazardous dust from chipping or grinding operations, chipper and grinder workers must be provided with the appropriate supplemental PPE.

—Safety Glasses
—Transparent Face Shields
—Hearing Protection
—Foot Protection
—Gloves
(Signed and Dated)

Example 4:

the workplace hazards to which shipyard painters are exposed, the equipment listed below is the basic PPE required for this occupation. Where painters are exposed to other hazards, such as a fall from an elevation where no guardrails are present, painters must be provided with the appropriate supplemental PPE.

—Hard Hats
—Safety Glasses
—Disposable Clothing
—Gloves
—Respiratory Protection, including Airline Respirators when working in Confined Spaces
—Barrier Creams
(Signed and Dated)

Example 5:

ations and the basic PPE required for them depend largely upon the type of cargo shipped in the tank. Therefore, the following example is given for a tank in which gasoline has been shipped. Based on an assessment of the workplace hazards to which shipyard tank cleaners are exposed, specifically benzene and flammability hazards, the equipment listed below is the basic PPE required for this situation. Other tank cleaning operations will require variations in the PPE listed below.

—Respiratory Protection, Airline Respirators for working in confined spaces or where personal exposure limits could be exceeded.
—Chemically resistant clothing
—Face Shields
—Chemically resistant boots
—Chemically resistant gloves
—Fall Protection
—Non sparking tools and equipment
—Explosion-proof Lighting
(Signed and Dated)

APPENDIX B TO SUBPART I OF PART 1915—GENERAL TESTING CONDITIONS AND ADDITIONAL GUIDELINES FOR PERSONAL FALL PROTECTION SYSTEMS (NON-MANDATORY)

1. *Personal fall arrest systems*—(a) *General test conditions.* (1) Lifelines, lanyards, and deceleration devices should be attached to an anchorage and connected to the body-belt or body harness in the same manner as they would be when used to protect employees, except that lanyards should be tested only when connected directly to the anchorage, and not when connected to a lifeline.

(2) The anchorage should be rigid, and should not have a deflection greater than .04 inches (1 cm) when a force of 2,250 pounds (10 Kn) is applied.

(3) The frequency response of the load measuring instrumentation should be 100 Hz.

(4) The test weight used in the strength and force tests should be a rigid, metal cylindrical or torso-shaped object with a girth of 38 inches plus or minus 4 inches (96.5 cm plus or minus 10 cm).

(5) The lanyard or lifeline used to create the free fall distance should be the one supplied with the system, or in its absence, the least elastic lanyard or lifeline available to be used by the employee with the system.

(6) The test weight for each test should be hoisted to the required level and should be quickly released without having any appreciable motion imparted to it.

(7) The system's performance should be evaluated, taking into account the range of environmental conditions for which it is designed to be used.

(8) Following the test, the system need not be capable of further operation.

(b) *Strength test.* (1) During the testing of all systems, a test weight of 300 pounds plus or minus 5 pounds (136 kg plus or minus 2.27 kg) should be used. (See paragraph (a)(4) above.)

(2) The test consists of dropping the test weight once. A new unused system should be used for each test.

(3) For lanyard systems, the lanyard length should be 6 feet plus or minus 2 inches (1.83 m plus or minus 5 cm) as measured from the fixed anchorage to the attachment on the body belt or harness.

(4) For rope-grab-type deceleration systems, the length of the lifeline above the center line of the grabbing mechanism to the lifeline's anchorage point should not exceed 2 feet (0.61 m).

(5) For lanyard systems, for systems with deceleration devices which do not automatically limit free fall distance to 2 feet (0.61 m) or less, and for systems with deceleration devices which have a connection distance in excess of 1 foot (0.3 m) (measured between the centerline of the lifeline and the attachment point to the body belt or harness), the test weight should be rigged to free fall a distance of 7.5 feet (2.3 m) from a point that is 1.5 feet (46 cm) above the anchorage point, to its hanging location (6 feet (1.83 m) below the anchorage). The test weight should fall without interference, obstruction, or hitting the floor or the ground during the test. In some cases, a non-elastic wire lanyard of sufficient length may need to be added to the system (for test purposes) to create the necessary free fall distance.

(6) For deceleration device systems with integral lifelines or lanyards which automatically limit free fall distance to 2 feet (0.61 m) or less, the test weight should be rigged to free fall a distance of four feet (1.22 m).

(7) Any weight which detaches from the belt or harness should constitute failure for the strength test.

(c) *Force test general.* The test consists of dropping the respective test weight once. A new, unused system should be used for each test.

(1) For lanyard systems. (i) A test weight of 220 pounds plus or minus three pounds (100 kg plus or minus 1.6 kg) should be used (see paragraph (a)(4) above).

(ii) Lanyard length should be 6 feet plus or minus 2 inches (1.83 m plus or minus 5 cm) as measured from the fixed anchorage to the attachment on the body belt or body harness.

(iii) The test weight should fall free from the anchorage level to its handling location (a total of 6 feet (1.83 m) free fall distance) without interference, obstruction, or hitting the floor or ground during the test.

(2) For all other systems. (i) A test weight of 220 pounds plus or minus 3 pounds (100 kg plus or minus 1.6 kg) should be used (see paragraph (a)(4) above).

(ii) The free fall distance to be used in the test should be the maximum fall distance physically permitted by the system during normal use conditions, up to a maximum free fall distance for the test weight of 6 feet (1.83 m), except as follows:

(A) For deceleration systems which have a connection link or lanyard, the test weight should free fall a distance equal to the connection distance (measured between the center line of the lifeline and the attachment point to the body belt or harness).

(B) For deceleration device systems with integral life lines or lanyards which automatically limit free fall distance to 2 feet (0.61 m) or less, the test weight should free fall a distance equal to that permitted by the system in normal use. (For example, to test a system with a self-retracting lifeline or lanyard, the test weight should be supported and the system allowed to retract the lifeline or lanyard as it would in normal use. The test weight would then be released and the force and deceleration distance measured.)

(3) Failure. A system fails the force test if the recorded maximum arresting force exceeds 1,260 pounds (5.6 Kn) when using a body belt, or exceeds 2,520 pounds (11.2 Kn) when using a body harness.

(4) Distances. The maximum elongation and deceleration distance should be recorded during the force test.

(d) *Deceleration device tests—general.* The device should be evaluated or tested under the environmental conditions (such as rain, ice, grease, dirt, type of lifeline, etc.) for which the device is designed.

(1) Rope-grab-type deceleration devices. (i) Devices should be moved on a lifeline 1,000 times over the same length of line a distance of not less than 1 foot (30.5 cm), and the mechanism should lock each time.

(ii) Unless the device is permanently marked to indicate the type of lifelines which must be used, several types (different diameters and different materials) of lifelines should be used to test the device.

(2) Other-self-activating-type deceleration devices. The locking mechanisms of other self-activating-type deceleration devices designed for more than one arrest should lock each of 1,000 times as they would in normal service.

2. *Positioning device systems*—(a) *Test Conditions.* (1) The fixed anchorage should be rigid and should not have a deflection greater than .04 inches (1 cm) when a force of 2,250 pounds (10 Kn) is applied.

(2) For linemen's body belt and pole straps, the body belt should be secured to a 250

pound (113 kg) bag of sand at a point which simulates the waist of an employee. One end of the pole strap should be attached to the rigid anchorage and the other end to the body belt. The sand bag should be allowed to free fall a distance of 4 feet (1.2 m). Failure of the pole strap and body belt should be indicated by any breakage or slippage sufficient to permit the bag to fall free to the ground.

(3) For window cleaner's belts, the complete belt should withstand a drop test consisting of a 250 pound (113 kg) weight falling free for a distance of 6 feet (1.83 m). The weight should be a rigid object with a girth of 38 inches plus or minus four inches (97 cm plus or minus 10 cm). The weight should be placed in the waistband with the belt buckle drawn firmly against the weight, as when the belt is worn by a window cleaner. One belt terminal should be attached to a rigid anchor and the other terminal should hang free. The terminals should be adjusted to their maximum span. The weight fastened in the freely suspended belt should then be lifted exactly 6 feet (1.83 m) above its ''at rest'' position and released so as to permit a free fall of 6 feet (1.83 m) vertically below the point of attachment of the terminal anchor. The belt system should be equipped with devices and instrumentation capable of measuring the duration and magnitude of the arrest forces. Any breakage or slippage which permits the weight to fall free of the system constitutes failure of the test. In addition, the initial and subsequent arresting force peaks should be measured and should not exceed 2,000 pounds (8.9 Kn) for more than 2 milliseconds for the initial impact, nor exceed 1,000 pounds (4.45 Kn) for the remainder of the arrest time.

(4) All other positioning device systems (except for restraint line systems) should withstand a drop test consisting of a 250 pound (113 kg) weight falling free for a distance of 4 feet (1.2 m). The weight should be a rigid object with a girth of 38 inches plus or minus 4 inches (96 cm plus or minus 10 cm). The body belt or harness should be affixed to the test weight as it would be to an employee. The system should be connected to the rigid anchor in the manner that the system would be connected in normal use. The weight should be lifted exactly 4 feet (1.2 m) above its ''at rest'' position and released so as to permit a vertical free fall of 4 feet (1.2 m). Any breakage or slippage which permits the weight to fall free to the ground should constitute failure of the system.

Subpart J—Ship's Machinery and Piping Systems

§ 1915.161 Scope and application of subpart.

The standards contained in this subpart shall apply to ship repairing and shipbuilding and shall not apply to shipbreaking.

§ 1915.162 Ship's boilers.

(a) Before work is performed in the fire, steam, or water spaces of a boiler where employees may be subject to injury from the direct escape of a high temperature medium such as steam, or water, oil, or other medium at a high temperature entering from an interconnecting system, the employer shall insure that the following steps are taken:

(1) The isolation and shutoff valves connecting the dead boiler with the live system or systems shall be secured, blanked, and tagged indicating that employees are working in the boiler. This tag shall not be removed nor the valves unblanked until it is determined that this may be done without creating a hazard to the employees working in the boiler, or until the work in the boiler is completed. Where valves are welded instead of bolted at least two isolation and shutoff valves connecting the dead boiler with the live system or systems shall be secured, locked, and tagged.

(2) Drain connections to atmosphere on all of the dead interconnecting systems shall be opened for visual observation of drainage.

(3) A warning sign calling attention to the fact that employees are working in the boilers shall be hung in a conspicuous location in the engine room. This sign shall not be removed until it is determined that the work is completed and all employees are out of the boilers.

§ 1915.163 Ship's piping systems.

(a) Before work is performed on a valve, fitting, or section of piping in a piping system where employees may be subject to injury from the direct escape

of steam, or water, oil, or other medium at a high temperature, the employer shall insure that the following steps are taken:

(1) The isolation and shutoff valves connecting the dead system with the life system or systems shall be secured, blanked, and tagged indicating that employees are working on the systems. This tag shall not be removed nor the valves unblanked until it is determined that this may be done without creating a hazard to the employees working on the system, or until the work on the system is completed. Where valves are welded instead of bolted at least two isolation and shutoff valves connecting the dead system with the live system or systems shall be secured, locked, and tagged.

(2) Drain connections to atmosphere on all of the dead interconnecting systems shall be opened for visual observation of drainage.

§ 1915.164 Ship's propulsion machinery.

(a) Before work is performed on the main engine, reduction gear, or connecting accessories, the employer shall ensure that the following steps are taken:

(1) The jacking gear shall be engaged to prevent the main engine from turning over. A sign shall be posted at the throttle indicating that the jacking gear is engaged. This sign shall not be removed until the jacking gear can be safely disengaged.

(2) If the jacking gear is steam driven, the stop valves to the jacking gear shall be secured, locked, and tagged indicating that employees are working on the main engine.

(3) If the jacking gear is electrically driven, the circuit controlling the jacking gear shall be deenergized by tripping the circuit breaker, opening the switch or removing the fuse, whichever is appropriate. The breaker, switch, or fuse location shall be tagged indicating that employees are working on the main engine.

(b) Before the jacking engine is operated, the following precautions shall be taken:

(1) A check shall be made to ensure that all employees, equipment, and tools are clear of the engine, reduction gear, and its connecting accessories.

(2) A check shall be made to ensure that all employees, equipment and tools are free of the propeller.

(c) Before work is started on or in the immediate vicinity of the propeller, a warning sign calling attention to the fact that employees are working in that area shall be hung in a conspicuous location in the engine room. This sign shall not be removed until it is determined that the work is completed and all employees are free of the propeller.

(d) Before the main engine is turned over (e.g., when warming up before departure or testing after an overhaul) a check shall be made to ensure that all employees, equipment, and tools are free of the propeller.

§ 1915.165 Ship's deck machinery.

(a) Before work is performed on the anchor windlass or any of its attached accessories, the employer shall ensure that the following steps are taken:

(1) The devil claws shall be made fast to the anchor chains.

(2) The riding pawls shall be in the engaged position.

(3) In the absence of devil claws and riding pawls, the anchor chains shall be secured to a suitable fixed structure of the vessel.

Subpart K—Portable, Unfired Pressure Vessels, Drums and Containers, Other Than Ship's Equipment

§ 1915.171 Scope and application of subpart.

The standards contained in this subpart shall apply to ship repairing and shipbuilding and shall not apply to shipbreaking.

§ 1915.172 Portable air receivers and other unfired pressure vessels.

(a) Portable, unfired pressure vessels, built after the effective date of this regulation, shall be marked and reported indicating that they have been designed and constructed to meet the standards of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XIII, Rules for Construction of Unfired Pressure

Vessels, 1963. They shall be subjected to a hydrostatic pressure test of one and one-half times the working pressure of the vessels.

(b) Portable, unfired pressure vessels, not built to the code requirements of paragraph (a) of this section, and built prior to the effective date of this regulation, shall be examined quarterly by a competent person. They shall be subjected yearly to a hydrostatic pressure test of one and one-half times the working pressure of the vessels.

(c) The relief valves on the portable, unfired pressure vessels in paragraphs (a) and (b) of this section shall be set to the safe working pressure of the vessels, or set to the lowest safe working pressure of the systems, whichever is lower.

(d) A certification record of such examinations and tests made in compliance with the requirements of paragraphs (a) and (b) of this section shall be maintained. The certification record shall include the date of examinations and tests, the signature of the person who performed the examinations or tests and the serial number, or other identifier, of the equipment examined and tested.

[47 FR 16986, Apr. 20, 1982, as amended at 51 FR 34562, Sept. 29, 1986]

§ 1915.173 Drums and containers.

(a) Shipping drums and containers shall not be pressurized to remove their contents.

(b) A temporarily assembled pressurized piping system conveying hazardous liquids or gases shall be provided with a relief valve and by-pass to prevent rupture of the system and the escape of such hazardous liquids or gases.

(c) Pressure vessels, drums and containers containing toxic or flammable liquids or gases shall not be stored or used where they are subject to open flame, hot metal, or other sources of artificial heat.

(d) Unless pressure vessels, drums and containers of 30 gallon capacity or over containing flammable or toxic liquids or gases are placed in an out-of-the-way area where they will not be subject to physical injury from an outside source, barriers or guards shall be erected to protect them from such physical injury.

(e) Containers of 55 gallons or more capacity containing flammable or toxic liquid shall be surrounded by dikes or pans which enclose a volume equal to at least 35 percent of the total volume of the containers.

(f) Fire extinguishers adequate in number and suitable for the hazard shall be provided. These extinguishers shall be located in the immediate area where pressure vessels, drums and containers containing flammable liquids or gases are stored or in use. Such extinguishers shall be ready for use at all times.

Subpart L—Electrical Machinery

§ 1915.181 Electrical circuits and distribution boards.

(a) The provisions of this section shall apply to ship repairing and shipbuilding and shall not apply to shipbreaking.

(b) Before an employee is permitted to work on an electrical circuit, except when the circuit must remain energized for testing and adjusting, the circuit shall be deenergized and checked at the point at which the work is to be done to insure that it is actually deenergized. When testing or adjusting an energized circuit a rubber mat, duck board, or other suitable insulation shall be used underfoot where an insulated deck does not exist.

(c) Deenergizing the circuit shall be accomplished by opening the circuit breaker, opening the switch, or removing the fuse, whichever method is appropriate. The circuit breaker, switch, or fuse location shall be tagged to indicate that an employee is working on the circuit. Such tags shall not be removed nor the circuit energized until it it definitely determined that the work on the circuit has been completed.

(d) When work is performed immediately adjacent to an open-front energized board or in back of an energized board, the board shall be covered or some other equally safe means shall be used to prevent contact with any of the energized parts.

Subparts M–Y [Reserved]

Subpart Z—Toxic and Hazardous Substances

SOURCE: 58 FR 35514, July 1, 1993, unless otherwise noted.

§ 1915.1000 Air contaminants.

Wherever this section applies, an employees's exposure to any substance listed in Table Z—Shipyards of this section shall be limited in accordance with the requirements of the following paragraphs of this section.

(a)(1) *Substances with limits preceded by ''C''—Ceiling values.* An employee's exposure to any substance in Table Z—Shipyards, the exposure limit of which is preceded by a ''C,'' shall at no time exceed the exposure limit given for that substance. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time over a working day.

(2) *Other Substances—8-hour Time Weighted Averages.* An employee's exposure to any substance in Table Z—Shipyards , the exposure limit of which is not preceded by a ''C,'' shall not exceed the 8-hour Time Weighted Average given for that substance in any 8-hour work shift of a 40-hour work week.

(b)–(c) [Reserved]

(d) *Computation formulae.* The computation formula which shall apply to employee exposure to more than one substance for which 8-hour time weighted averages are listed in subpart Z of 29 CFR part 1915 in order to determine whether an employee is exposed over the regulatory limit is as follows:

(1)(i) The cumulative exposure for an 8-hour work shift shall be computed as follows:

$$E = (C_a T_a + C_b T_b + \ldots C_n T_n) \div 8$$

Where:

E is the equivalent exposure for the working shift.

C is the concentration during any period of time T where the concentration remains constant.

T is the duration in hours of the exposure at the concentration C.

The value of E shall not exceed the 8-hour time weighted average specified in subpart Z of 29 CFR part 1915 for the material involved.

(ii) To illustrate the formula prescribed in paragraph (d)(1)(i) of this section, assume that Substance A has an 8-hour time weighted average limit of 100 ppm noted in Table Z—Shipyards. Assume that an employee is subject to the following exposure:

Two hours exposure at 150 p/m
Two hours exposure at 75 p/m
Four hours exposure at 50 p/m

Substituting this information in the formula, we have

$$(2\times150+2\times75+4\times50)\div8=81.25 \text{ p/m}$$

Since 81.25 ppm is less than 100 ppm, the 8-hour time weighted average limit, the exposure is acceptable.

(2)(i) in case of a mixture of air contaminants an employer shall compute the equivalent exposure as follows:

$$E_m = (C_1 \div L_1 + C_2 \div L_2) + \ldots (C_n \div L_n)$$

Where:

E_m is the equivalent exposure for the mixture.

C is the concentration of a particular contaminant.

L is the exposure limit for that substance specified in subpart Z of 29 CFR part 1915.

The value of E_m shall not exceed unity (1).

(ii) To illustrate the formula prescribed in paragraph (d)(2)(i) of this section, consider the following exposures:

Substance	Actual concentration of 8 hour exposure (ppm)	8 hr. TWA PEL (ppm)
B	500	1000
C	45	200
D	40	200

Substituting in the formula, we have:
Em=500÷1,000+45÷200+40÷200
Em=0.500+0.225+0.200
Em=0.925

Since Em is less than unity (1), the exposure combination is within acceptable limits.

TABLE Z—SHIPYARDS

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Abate; see Temephos.				
Acetaldehyde	75–07–0	200	360	—
Acetic acid	64–19–7	10	25	—
Acetic anhydride	108–24–7	5	20	—
Acetone	67–64–1	1000	2400	—
Acetonitrile	75–05–8	40	70	—
2-Acetylaminofluorine; see § 1915.1014	53–96–3			
Acetylene	74–86–2	E		
Acetylene dichloride; see 1,2-Dichloroethylene.				
Acetylene tetrabromide	79–27–6	1	14	—
Acrolein	107–02–8	0.1	0.25	—
Acrylamide	79–06–1	—	0.3	X
Acrylonitrile; see § 1915.1045	107–13–1			
Aldrin	309–00–2	—	0.25	X
Allyl alcohol	107–18–6	2	5	X
Allyl chloride	107–05–1	1	3	—
Allyl glycidyl ether (AGE)	106–92–3	(C)10	(C)45	—
Allyl propyl disulfide	2179–59–1	2	12	—
alpha-Alumina	1344–28–1			
Total dust		—	15	—
Respirable fraction		—	5	—
Aluminum, (as Al) Metal	7429–90–5			
Total dust		—	15	—
Respirable fraction		—	5	—
Alundum; see alpha-Alumina				
4-Aminodiphenyl; see § 1915.1011	92–67–1			
2-Aminoethanol; see Ethanolamine.				
2-Aminopyridine	504–29–0	0.5	2	—
Ammonia	7664–41–7	50	35	—
Ammonium sulfamate	7773–06–0			
Total dust		—	15	—
Respirable fraction		—	5	—
n-Amyl acetate	628–63–7	100	525	—
sec-Amyl acetate	626–38–0	125	650	—
Aniline and homologs	62–53–3	5	19	X
Anisidine (o-, p-isomers)	29191–52–4	—	0.5	X
Antimony and compounds (as Sb)	7440–36–0	—	0.5	—
ANTU (alpha Naphthylthiourea)	86–88–4	—	0.3	—
Argon	7440–37–1	E		
Arsenic, inorganic compounds (as As); see § 1915.1018	7440–38–2	—	—	—
Arsenic, organic compounds (as As)	7440–38–2	—	0.5	—
Arsine	7784–42–1	0.05	0.2	—
Asbestos; see 1915.1001.				
Azinphos-methyl	86–50–0	—	0.2	X
Barium, soluble compounds (as Ba)	7440–39–3	—	0.5	—
Barium sulfate	7727–43–7			
Total dust		—	15	—
Respirable fraction		—	5	—
Benomyl	17804–35–2			
Total dust		—	15	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Respirable fraction ...		—	5	—
Benzene[g]; see § 1915.1028	71–43–2			
Benzidine; see § 1915.1010	92–87–5			
p-Benzoquinone; see Quinone.				
Benzo(a)pyrene; see Coal tar pitch volatiles.				
Benzoyl peroxide	94–36–0	—	5	—
Benzyl chloride	100–44–7	1	5	—
Beryllium and beryllium compounds (as Be)	7440–41–7	—	0.002	—
Biphenyl; see Diphenyl.				
Bismuth telluride, Undoped	1304–82–1			
Total dust		—	15	—
Respirable fraction ...		—	5	—
Bisphenol A; see Diglycidyl ether.				
Boron oxide	1303–86–2			
Total dust		—	15	—
Boron tribromide	10294–33–4	1	10	—
Boron trifluoride	7637–07–2	(C)1	(C)3	—
Bromine	7726–95–6	0.1	0.7	—
Bromine pentafluoride	7789–30–2	0.1	0.7	—
Bromoform	75–25–2	0.5	5	X
Butadiene (1,3-Butadiene); see 29 CFR 1910.1051; 29 CFR 1910.19(l)	106–99–0	1 ppm/5 ppm STEL	—	—
Butanethiol; see Butyl mercaptan.				
2-Butanone (Methyl ethyl ketone)	78–93–3	200	590	—
2-Butoxyethanol	111–76–2	50	240	X
n-Butyl-acetate	123–86–4	150	710	—
sec-Butyl acetate	105–46–4	200	950	—
tert-Butyl acetate	540–88–5	200	950	—
n-Butyl alcohol	71–36–3	100	300	—
sec-Butyl alcohol	78–92–2	150	450	—
tert-Butyl alcohol	75–65–0	100	300	—
Butylamine	109–73–9	(C)5	(C)15	X
tert-Butyl chromate (as CrO_3)	1189–85–1	—	(C)0.1	X
n-Butyl glycidyl ether (BGE)	2426–08–6	50	270	—
Butyl mercaptan	109–79–5	0.5	1.5	—
p-tert-Butyltoluene	98–51–1	10	60	—
Cadmium dust fume (as Cd); see 1915.1027	7440–43–9	—	—	—
Calcium carbonate	1317–65–3			
Total dust		—	15	—
Respirable fraction ...		—	5	—
Calcium hydroxide	1305–62–0	—	—	—
Calcium hydroxide.				
Total dust		—	15	—
Respirable fraction ...		—	5	—
Calcium oxide	1305–78–8	—	5	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Calcium silicate	1344–95–2			
Total dust		—	15	—
Respirable fraction		—	5	—
Calcium sulfate	7778–18–9			
Total dust		—	15	—
Respirable fraction		—	5	—
Camphor, synthetic	76–22–2	—	2	—
Carbaryl (Sevin)	63–25–2	—	5	—
Carbon black	1333–86–4	—	3.5	—
Carbon dioxide	124–38–9	5000	9000	—
Carbon disulfide	75–15–0	20	60	X
Carbon monoxide	630–08–0	50	55	—
Carbon tetrachloride	56–23–5	10	65	X
Cellulose	9004–34–6			
Total dust		—	15	—
Respirable fraction		—	5	—
Chlordane	57–74–9	—	0.5	X
Chlorinated camphene	8001–35–2	—	0.5	X
Chlorinated diphenyl oxide	55720–99–5	—	0.5	—
Chlorine	7782–50–5	1	3	—
Chlorine trifluoride	7790–91–2	(C)0.1	(C)0.4	—
Chloroacetaldehyde	107–20–0	(C)1	(C)3	—
a-Chloroacetophenone (Phenacyl chloride)	532–27–4	0.05	0.3	—
Chlorobenzene	108–90–7	75	350	—
o-Chlorobenzylidene malononitrile	2698–41–1	0.05	0.4	—
Chlorobromomethane	74–97–5	200	1050	—
2-Chloro-1,3-butadiene; see beta-Chloroprene.				
Chlorodiphenyl (42% Chlorine) (PCB)	53469–21–9	—	1	X
Chlorodiphenyl (54% Chlorine) (PCB)	11097–69–1	—	0.5	X
1-Chloro,2,3-epoxypropane; see Epichlorohydrin.				
2-Chloroethanol; see Ethylene chlorohydrin.				
Chloroethylene; see Vinyl chloride.				
Chloroform (Trichloromethane)	67–66–3	50	240	—
bis(Chloromethyl) ether; see § 1915.1008	542–88–1			
Chloromethyl methyl ether; see § 1915.1006	107–30–2			
1-Chloro-1-nitropropane	600–25–9	20	100	—
Chloropicrin	76–06–2	0.1	0.7	
beta-Chloroprene	126–99–8	25	90	X
2-Chloro-6-(trichloromethyl) pyridine	1929–82–4			
Total dust		—	15	—
Respirable fraction		—	5	—
Chromic acid and chromates. (as CrO_3)	Varies with compound	—	0.1	—
Chromium (II) compounds. (as Cr)	7440–47–3	—	0.5	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Chromium (III) compounds. (as Cr)	7440–47–3	—	0.5	—
Chromium metal and insol. salts (as Cr)	7440–47–3	—	1	—
Chrysene; see Coal tar pitch volatiles.				
Clopidol	2971–90–6			
Total dust		—	15	—
Respirable fraction		—	5	—
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966–93–2	—	0.2	—
Cobalt metal, dust, and fume (as Co)	7440–48–4	—	0.1	—
Copper	7440–50–8			
Fume (as Cu)		—	0.1	—
Dusts and mists (as Cu)		—	1	—
Corundum; see Emery.				
Cotton dust (raw)		—	1	
Crag herbicide (Sesone)	136–78–7			
Total dust		—	15	—
Respirable fraction		—	5	—
Cresol, all isomers	1319–77–3	5	22	X
Crotonaldehyde	123–73–9; 4170–30–3	2	6	
Cumene	98–82–8	50	245	X
Cyanides (as CN)	Varies with Compound	—	5	—
Cyanogen	460–19–5	10	—	—
Cyclohexane	110–82–7	300	1050	—
Cyclohexanol	108–93–0	50	200	—
Cyclohexanone	108–94–1	50	200	—
Cyclohexene	110–83–8	300	1015	—
Cyclonite	121–82–4	—	1.5	X
Cyclopentadiene	542–92–7	75	200	—
2,4-D (Dichlorophenoxyacetic acid)	94–75–7	—	10	—
Decaborane	17702–41–9	0.05	0.3	X
Demeton (Systox)	8065–48–3	—	0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123–42–2	50	240	—
1,2-Diaminoethane; see Ethylenediamine.				
Diazomethane	334–88–3	0.2	0.4	—
Diborane	19287–45–7	0.1	0.1	—
1,2-Dibromo-3-chloropropane (CBCP); see § 1915.1044	96–12–8		—	
1,2-Dibromoethane; see Ethylene dibromide.				
Dibutyl phosphate	107–66–4	1	5	—
Dibutyl phthalate	84–74–2	—	5	—
Dichloroacetylene	7572–29–4	(C)0.1	(C)0.4	—
o-Dichlorobenzene	95–50–1	(C)50	(C)300	—
p-Dichlorobenzene	106–46–7	75	450	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
3,3'-Dichlorobenzidine; see § 1915.1007	91–94–1			
Dichlorodifluoromethane	75–71–8	1000	4950	—
1,3-Dichloro-5,5-dimethyl hydantoin	118–52–5	—	0.2	—
Dichlorodiphenyltrichloroethane (DDT)	50–29–3	—	1	X
1,1-Dichloroethane	75–34–3	100	400	—
1,2-Dichloroethane; see Ethylene dichloride.				
1,2-Dichloroethylene	540–59–0	200	790	—
Dichloroethyl ether	111–44–4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride.				
Dichloromonofluoromethane	75–43–4	1000	4200	—
1,1-Dichloro-1-nitroethane	594–72–9	(C)10	(C)60	—
1,2-Dichloropropane; see Propylene dichloride.				
Dichlorotetrafluoroethane	76–14–2	1000	7000	—
Dichlorvos (DDVP)	62–73–7	—	1	X
Dicyclopentadienyl iron	102–54–5			
Total dust		—	15	—
Respirable fraction		—	5	—
Dieldrin	60–57–1	—	0.25	X
Diethylamine	109–89–7	25	75	—
2-Diethylaminoethanol	100–37–8	10	50	—
Diethylene triamine	111–40–0	(C)10	(C)42	X
Diethyl ether; see Ethyl ether.				
Difluorodibromomethane	75–61–6	100	860	—
Diglycidyl ether (DGE)	2238–07–5	(C)0.5	(C)2.8	—
Dihydroxybenzene; see Hydroquinone.				
Diisobutyl ketone	108–83–8	50	290	—
Diisopropylamine	108–18–9	5	20	X
4-Dimethylaminoazobenzene; see § 1915.1015	60–11–7			
Dimethoxymethane; see Methylal.				
Dimethyl acetamide	127–19–5	10	35	X
Dimethylamine	124–40–3	10	18	—
Dimethylaminobenzene; see Xylidine.				
Dimethylaniline (N,N-Dimethylaniline)	121–69–7	5	25	X
Dimethylbenzene; see Xylene.				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300–76–5	—	3	—
Dimethylformamide	68–12–2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone.				
1,1-Dimethylhydrazine	57–14–7	0.5	1	X
Dimethylphthalate	131–11–3	—	5	—
Dimethyl sulfate	77–78–3	1	5	X
Dinitrobenzene (all isomers)			1	X
(ortho)	528–29–0			

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
(meta)	99–65–0			
(para)	100–25–4			
Dinitro-o-cresol	534–52–1	—	0.2	X
Dinitrotoluene	25321–14–6	—	1.5	X
Dioxane (Diethylene dioxide)	123–91–1	100	360	X
Diphenyl (Biphenyl)	92–52–4	0.2	1	—
Diphenylamine	122–39–4	—	10	—
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate.				
Dipropylene glycol methyl ether	34590–94–8	100	600	X
Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate)	117–81–7	—	5	—
Emery	12415–34–8			
Total dust		—	15	—
Respirable fraction		—	5	—
Endosulfan	115–29–7	—	0.1	X
Endrin	72–20–8	—	0.1	X
Epichlorohydrin	106–89–8	5	19	X
EPN	2104–64–5	—	0.5	X
1,2-Epoxypropane; see Propylene oxide.				
2,3-Epoxy-1-propanol; see Glycidol.				
Ethane	74–84–0	E		
Ethanethiol; see Ethyl mercaptan.				
Ethanolamine	141–43–5	3	6	—
2-Ethoxyethanol (Cellosolve)	110–80–5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111–15–9	100	540	X
Ethyl acetate	141–78–6	400	1400	—
Ethyl acrylate	140–88–5	25	100	X
Ethyl alcohol (Ethanol)	64–17–5	1000	1900	—
Ethylamine	75–04–7	10	18	—
Ethyl amyl ketone (5-Methyl-3-heptanone)	541–85–5	25	130	—
Ethyl benzene	100–41–4	100	435	—
Ethyl bromide	74–96–4	200	890	—
Ethyl butyl ketone (3-Heptanone)	106–35–4	50	230	—
Ethyl chloride	75–00–3	1000	2600	—
Ethyl ether	60–29–7	400	1200	—
Ethyl formate	109–94–4	100	300	—
Ethyl mercaptan	75–08–1	0.5	1	—
Ethyl silicate	78–10–4	100	850	—
Ethylene	74–85–1	E		
Ethylene chlorohydrin	107–07–3	5	16	X
Ethylenediamine	107–15–3	10	25	—
Ethylene dibromide	106–93–4	(C)25	(C)190	X
Ethylene dichloride (1,2-Dichloroethane)	107–06–2	50	200	—
Ethylene glycol dinitrate	628–96–6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate.				
Ethyleneimine; see § 1915.1012	151–56–4			

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Ethylene oxide; see § 1915.1047	75–21–8			
Ethylidene chloride; see 1,1-Dichloroethane.				
N-Ethylmorpholine	100–74–3	20	94	X
Ferbam	14484–64–1			
Total dust		—	15	—
Ferrovanadium dust	12604–58–9	—	1	—
Fibrous Glass.				
Total dust			15	—
Respirable fraction		—	5	—
Fluorides (as F)	Varies with compound	—	2.5	—
Fluorine	7782–41–4	0.1	0.2	—
Fluorotrichloromethane (Trichlorofluoromethane)	75–69–4	1000	5600	—
Formaldehyde; see § 1915.1048	50–00–0			
Formic acid	64–18–6	5	9	—
Furfural	98–01–1	5	20	X
Furfuryl alcohol	98–00–0	50	200	—
Gasoline	8006–61–9		A[3]	—
Glycerin (mist)	56–81–5			
Total dust		—	15	—
Respirable fraction		—	5	—
Glycidol	556–52–5	50	150	—
Glycol monoethyl ether; see 2-Ethoxyethanol.				
Graphite, natural, respirable dust	7782–42–5	([2])	([2])	([2])
Graphite, synthetic				
Total dust		—	15	—
Respirable fraction		—	5	—
Guthion; see Azinphos methyl.				
Gypsum	13397–24–5			
Total dust		—	15	—
Respirable fraction		—	5	—
Hafnium	7440–58–6	—	0.5	—
Helium	7440–59–7	E		
Heptachlor	76–44–8	—	0.5	X
Heptane (n-Heptane)	142–82–5	500	2000	—
Hexachloroethane	67–72–1	1	10	X
Hexachloronaphthalene	1335–87–1	—	0.2	X
n-Hexane	110–54–3	500	1800	—
2-Hexanone (Methyl n-butyl ketone)	591–78–6	100	410	—
Hexone (Methyl isobutyl ketone)	108–10–1	100	410	—
sec-Hexyl acetate	108–84–9	50	300	—
Hydrazine	302–01–2	1	1.3	X
Hydrogen	1333–74–0	E		
Hydrogen bromide	10035–10–6	3	10	—
Hydrogen chloride	7647–01–0	(C)5	(C)7	—
Hydrogen cyanide	74–90–8	10	11	X
Hydrogen fluoride (as F)	7664–39–3	3	2	—
Hydrogen peroxide	7722–84–1	1	1.4	—
Hydrogen selenide (as Se)	7783–07–5	0.05		
Hydrogen sulfide	7783–06–4	10	15	—
Hydroquinone	123–31–9	—	2	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Indene	95–13–6	10	45	—
Indium and compounds (as In)	7440–74–6	—	0.1	—
Iodine	7553–56–2	(C)0.1	(C)1	—
Iron oxide fume	1309–37–1	—	10	—
Iron salts (soluble) (as Fe)	Varies with compound	—	1	—
Isoamyl acetate	123–92–2	100	525	—
Isoamyl alcohol (primary and secondary)	123–51–3	100	360	—
Isobutyl acetate	110–19–0	150	700	—
Isobutyl alcohol	78–83–1	100	300	—
Isophorone	78–59–1	25	140	—
Isopropyl acetate	108–21–4	250	950	—
Isopropyl alcohol	67–63–0	400	980	—
Isopropylamine	75–31–0	5	12	—
Isopropyl ether	108–20–3	500	2100	—
Isopropyl glycidyl ether (IGE)	4016–14–2	50	240	—
Kaolin	1332–58–7			
Total dust		—	15	—
Respirable fraction		—	5	—
Ketene	463–51–4	0.5	0.9	—
Lead, inorganic (as Pb); see § 1915.1025	7439–92–1	—	—	—
Limestone	1317–65–3			
Total dust		—	15	—
Respirable fraction		—	5	—
Lindane	58–89–9	—	0.5	X
Lithium hydride	7580–67–8	—	0.025	—
L.P.G. (Liquefied petroleum gas)	68476–85–7	1000	1800	
Magnesite	546–93–0			
Total dust		—	15	—
Respirable fraction		—	5	—
Magnesium oxide fume	1309–48–4			
Total particulate		15	—	—
Malathion	121–75–5			
Total dust		—	15	X
Maleic anhydride	108–31–6	0.25		
Manganese compounds (as Mn)	7439–96–5	—	(C)5	—
Manganese fume (as Mn)	7439–96–5	—	(C)5	—
Marble	1317–65–3			
Total dust		—	15	—
Respirable fraction		—	5	—
Mercury (aryl and inorganic)(as Hg)	7439–97–6		0.1	X
Mercury (organo) alkyl compounds (as Hg)	7439–97–6	—	0.01	X
Mercury (vapor) (as Hg)	7439–97–6	—	0.1	X
Mesityl oxide	141–79–7	25	100	—
Methane	74–82–8	E		
Methanethiol; see Methyl mercaptan.				
Methoxychlor	72–43–5			
Total dust		—	15	—
2-Methoxyethanol (Methyl cellosolve)	109–86–4	25	80	X

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
2-Methoxyethyl acetate (Methyl cellosolve acetate)	110–49–6	25	120	X
Methyl acetate	79–20–9	200	610	—
Methyl acetylene (Propyne)	74–99–7	1000	1650	—
Methyl acetylene-propadiene mixture (MAPP)		1000	1800	—
Methyl acrylate	96–33–3	10	35	X
Methylal (Dimethoxymethane)	109–87–5	1000	3100	—
Methyl alcohol	67–56–1	200	260	—
Methylamine	74–89–5	10	12	—
Methyl amyl alcohol; see Methyl isobutyl carbinol.				
Methyl n-amyl ketone	110–43–0	100	465	—
Methyl bromide	74–83–9	(C)20	(C)80	X
Methyl butyl ketone; see 2-Hexanone.				
Methyl cellosolve; see 2-Methoxyethanol.				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate.				
Methyl chloride	74–87–3	100	210	—
Methyl chloroform (1,1,1-Trichloroethane)	71–55–6	350	1900	—
Methylcyclohexane	108–87–2	500	2000	—
Methylcyclohexanol	25639–42–3	100	470	—
o-Methylcyclohexanone	583–60–8	100	460	X
Methylene chloride; see § 1910.1052.				
Methyl ethyl ketone (MEK); see 2-Butanone.				
Methyl formate	107–31–3	100	250	—
Methyl hydrazine (Monomethyl hydrazine)	60–34–4	(C)0.2	(C)0.35	X
Methyl iodide	74–88–4	5	28	X
Methyl isoamyl ketone	110–12–3	100	475	—
Methyl isobutyl carbinol	108–11–2	25	100	X
Methyl isobutyl ketone; see Hexone.				
Methyl isocyanate	624–83–9	0.02	0.05	X
Methyl mercaptan	74–93–1	0.5	1	—
Methyl methacrylate	80–62–6	100	410	100
Methyl propyl ketone; see 2-Pentanone.				
Methyl silicate	681–84–5	5	30	—
alpha-Methyl styrene	98–83–9	(C)100	(C)480	—
Methylene bisphenyl isocyanate (MDI)	101–68–8	(C)0.02	(C)0.2	—
Mica; see Silicates.				
Mineral wool.				
Total dust		—	15	—
Respirable dust		—	5	—
Molybdenum (as Mo)	7439–98–7			
Soluble compounds		—	5	—
Insoluble compounds.				
Total dust		—	15	—
Monomethyl aniline	100–61–8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine.				

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Morpholine	110–91–8	20	70	X
Naphtha (Coal tar)	8030–30–6	100	400	—
Naphthalene	91–20–3	10	50	—
alpha-Naphthylamine; see § 1915.1004	134–32–7			
beta-Naphthylamine; see § 1915.1009	91–59–8			—
Neon	7440–01–9	.....		
Nickel carbonyl (as Ni)	13463–39–3	0.001	0.007	—
Nickel, metal and insoluble compounds (as Ni)	7440–02–0	—	1	—
Nickel, soluble compounds (as Ni)	7440–02–0	—	1	—
Nicotine	54–11–5	—	0.5	X
Nitric acid	7697–37–2	2	5	—
Nitric oxide	10102–43–9	25	30	—
p-Nitroaniline	100–01–6	1	6	X
Nitrobenzene	98–95–3	1	5	X
p-Nitrochlorobenzene	100–00–5	—	1	X
4-Nitrodiphenyl; see § 1915.1003	92–93–3			
Nitroethane	79–24–3	100	310	—
Nitrogen	7727–37–9	E		
Nitrogen dioxide	10102–44–0	(C)5	(C)9	—
Nitrogen trifluoride	7783–54–2	10	29	—
Nitroglycerin	55–63–0	(C)0.2	(C)2	X
Nitromethane	75–52–5	100	250	—
1-Nitropropane	108–03–2	25	90	—
2-Nitropropane	79–46–9	25	90	—
N-Nitrosodimethylamine; see § 1915.1016	62–79–9			—
Nitrotoluene (all isomers)		5	30	X
o-isomer	88–72–2;			
m-isomer	99–08–1;			
p-isomer	99–99–0			
Nitrotrichloromethane; see Chloropicrin.				
Nitrous oxide	10024–97–2	E		
Octachloronaphthalene	2234–13–1	—	0.1	X
Octane	111–65–9	400	1900	—
Oil mist, mineral	8012–95–1	—	5	—
Osmium tetroxide (as Os)	20816–12–0	—	0.002	—
Oxalic acid	144–62–7	—	1	—
Oxygen difluoride	7783–41–7	0.05	0.1	—
Ozone	10028–15–6	0.1	0.2	—
Paraquat, respirable dust	4685–14–7; 1910–42–5; 2074–50–2	—	0.5	X
Parathion	56–38–2	—	0.1	—
Particulates not otherwise regulated.				
Total dust organic and inorganic		—	15	—
PCB; see Chlorodiphenyl (42% and 54% chlorine).				
Pentaborane	19624–22–7	0.005	0.01	—
Pentachloronaphthalene	1321–64–8	—	0.5	X
Pentachlorophenol	87–86–5	—	0.5	X
Pentaerythritol	115–77–5			
Total dust		—	15	—
Respirable fraction		—	5	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Pentane	109–66–0	500	1500	—
2-Pentanone (Methyl propyl ketone)	107–87–9	200	700	—
Perchloroethylene (Tetrachloroethylene)	127–18–4	100	670	—
Perchloromethyl mercaptan	594–42–3	0.1	0.8	—
Perchloryl fluoride	7616–94–6	3	13.5	—
Perlite	93763–70–3			
Total dust		—	15	—
Respirable fraction		—	5	—
Petroleum distillates (Naphtha)(Rubber Solvent)			A[3]	—
Phenol	108–95–2	5	19	X
p-Phenylene diamine	106–50–3	—	0.1	X
Phenyl ether, vapor	101–84–8	1	7	—
Phenyl ether-biphenyl mixture, vapor		1	7	—
Phenylethylene; see Styrene.				
Phenyl glycidyl ether (PGE)	122–60–1	10	60	—
Phenylhydrazine	100–63–0	5	22	X
Phosdrin (Mevinphos)	7786–34–7	—	0.1	X
Phosgene (Carbonyl chloride)	75–44–5	0.1	0.4	—
Phosphine	7803–51–2	0.3	0.4	—
Phosphoric acid	7664–38–2	—	1	—
Phosphorus (yellow)	7723–14–0	—	0.1	—
Phosphorus pentachloride	10026–13–8	—	1	—
Phosphorus pentasulfide	1314–80–3	—	1	—
Phosphorus trichloride	7719–12–2	0.5	3	—
Phthalic anhydride	85–44–9	2	12	—
Picloram	1918–02–1			
Total dust		—	15	—
Respirable fraction		—	5	—
Picric acid	88–89–1	—	0.1	—
Piperazine dihydrochloride	142–64–3	—	—	X
Pindone (2-Pivalyl-1,3-indandione)	83–26–1	—	0.1	—
Plaster of Paris	26499–65–0			
Total dust		—	15	—
Respirable fraction		—	5	—
Platinum (as Pt)	7440–06–4			
Metal		—	—	—
Soluble salts		—	0.002	—
Polytetrafluoroethylene decomposition products			A[2]	
Portland cement	65997–15–1			
Total dust		15	—	10
Respirable fraction		5	—	—
Propargyl alcohol	107–19–7	1	—	X
beta-Propriolactone; see § 1915.1013	57–57–8			
Propionic acid	79–09–4	—	—	—
n-Propyl acetate	109–60–4	200	840	—
n-Propyl alcohol	71–23–8	200	500	—
n-Propyl nitrate	627–13–4	25	110	—
Propylene dichloride	78–87–5	75	350	—
Propylene imine	75–55–8	2	5	X

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Propylene oxide	75–56–9	100	240	—
Propyne; see Methyl acetylene.				
Pyrethrum	8003–34–7	—	5	—
Pyridine	110–86–1	5	15	—
Quinone	106–51–4	0.1	0.4	—
RDX; see Cyclonite.				
Rhodium (as Rh), metal fume and insoluble compounds	7440–16–6	—	0.1	—
Rhodium (as Rh), soluble compounds	7440–16–6	—	0.001	—
Ronnel	299–84–3	—	10	—
Rotenone	83–79–4	—	5	—
Rouge		—		
Total dust		—	15	—
Respirable fraction		—	5	—
Selenium compounds (as Se)	7782–49–2	—	0.2	—
Selenium hexafluoride (as Se)	7783–79–1	0.05	0.4	—
Silica, amorphous, precipitated and gel	112926–00–8	(2)	(2)	(2)
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790–53–2	(2)	(2)	(2)
Silica, crystalline cristobalite, respirable dust	14464–46–1	(2)	(2)	(2)
Silica, crystalline quartz, respirable dust	14808–60–7	(2)	(2)	(2)
Silica, crystalline tripoli (as quartz), respirable dust	1317–95–9	(2)	(2)	(2)
Silica, crystalline tridymite, respirable dust	15468–32–3	(2)	(2)	(2)
Silica, fused, respirable dust	60676–86–0	(2)	(2)	(2)
Silicates (less than 1% crystalline silica).				
Mica (respirable dust)	12001–26–2	(2)	(2)	(2)
Soapstone, total dust	—	(2)	(2)	(2)
Soapstone, respirable dust	—	(2)	(2)	(2)
Talc (containing asbestos)	—	(3)	(3)	(3)
Talc (containing no asbestos), respirable dust	14807–96–6	(2)	(2)	(2)
Tremolite, asbestiform		(3)	(3)	(3)
Silicon	7440–21–3			
Total dust		—	15	—
Respirable fraction		—	5	—
Silicon carbide	409–21–2			
Total dust		—	15	—
Respirable fraction		—	5	—
Silver, metal and soluble compounds (as Ag)	7440–22–4	—	0.01	—
Soapstone; see Silicates.				

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Sodium fluoroacetate	62–74–8	—	0.05	X
Sodium hydroxide	1310–73–2	—	2	—
Starch	9005–25–8			
Total dust		—	15	—
Respirable fraction		—	5	—
Stibine	7803–52–3	0.1	0.5	—
Stoddard solvent	8052–41–3	200	1150	—
Strychnine	57–24–9	—	0.15	—
Styrene	100–42–5	100	420	50
Sucrose	57–50–1			
Total dust		—	15	—
Respirable fraction		—	5	—
Sulfur dioxide	7446–09–5	5	13	—
Sulfur hexafluoride	2551–62–4	1000	6000	—
Sulfuric acid	7664–93–9	—	1	—
Sulfur monochloride	10025–67–9	1	6	—
Sulfur pentafluoride	5714–22–7	0.025	0.25	—
Sulfuryl fluoride	2699–79–8	5	20	—
Systox, see Demeton.				
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93–76–5	—	10	—
Talc; see Silicates—.				
Tantalum, metal and oxide dust	7440–25–7	—	5	—
TEDP (Sulfotep)	3689–24–5	—	0.2	X
Teflon decomposition products			A2	
Tellurium and compounds (as Te)	13494–80–9	—	0.1	—
Tellurium hexafluoride (as Te)	7783–80–4	0.02	0.2	—
Temephos	3383–96–8			
Total dust		—	15	—
Respirable fraction		—	5	—
TEPP (Tetraethyl pyrophosphate)	107–49–3	—	0.05	X
Terphenyls	26140–60–3	(C)1	(C)9	—
1,1,1,2-Tetrachloro-2,2-difluoroethane	76–11–9	500	4170	—
1,1,2,2-Tetrachloro-1,2-difluoroethane	76–12–0	500	4170	—
1,1,2,2-Tetrachloroethane	79–34–5	5	35	X
Tetrachloroethylene; see Perchloroethylene.				
Tetrachloromethane; see Carbon tetrachloride.				
Tetrachloronaphthalene	1335–88–2	—	2	X
Tetraethyl lead (as Pb)	78–00–2	—	0.1	X
Tetrahydrofuran	109–99–9	200	590	—
Tetramethyl lead, (as Pb)	75–74–1	—	0.15	X
Tetramethyl succinonitrile	3333–52–6	0.5	3	X
Tetranitromethane	509–14–8	1	8	—
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479–45–8	—	1.5	X
Thallium, soluble compounds (as Tl)	7440–28–0	—	0.1	X
4,4'-Thiobis (6-tert, Butyl-m-cresol)	96–69–5			
Total dust		—	15	—
Respirable fraction		—	5	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a*]	mg/m[3b*]	Skin Designation
Thiram	137–26–8	—	5	—
Tin, inorganic compounds (except oxides) (as Sn)	7440–31–5	—	2	—
Tin, organic compounds (as Sn)	7440–31–5	—	0.1	—
Tin oxide (as Sn)	21651–19–4	—	—	—
Total dust		—	15	—
Respirable fraction		—	5	—
Titanium dioxide	13463–67–7			
Total dust		—	15	—
Toluene	108–88–3	200	750	100
Toluene-2,4-diisocyanate (TDI)	584–84–9	(C)0.02	(C)0.14	—
o-Toluidine	95–53–4	5	22	X
Toxaphene; see Chlorinated camphene.				
Tremolite; see Silicates.				
Tributyl phosphate	126–73–8	—	5	—
1,1,1-Trichloroethane; see Methyl chloroform.				
1,1,2-Trichloroethane	79–00–5	10	45	X
Trichloroethylene	79–01–6	100	535	—
Trichloromethane; see Chloroform.				
Trichloronaphthalene	1321–65–9	—	5	X
1,2,3-Trichloropropane	96–18–4	50	300	—
1,1,2-Trichloro-1,2,2-trifluoroethane	76–13–1	1000	7600	—
Triethylamine	121–44–8	25	100	—
Trifluorobromomethane	75–63–8	1000	6100	—
Trimethyl benzene	25551–13–7	25	120	—
2,4,6-Trinitrophenyl; see Picric acid.				
2,4,6-Trinitrophenylmethylnitramine; see Tetryl.				
2,4,6-Trinitrotoluene (TNT)	118–96–7	—	1.5	X
Triorthocresyl phosphate	78–30–8	—	0.1	—
Triphenyl phosphate	115–86–6	—	3	—
Tungsten (as W)	7440–33–7			
Insoluble compounds		—	5	—
Soluble compounds		—	1	—
Turpentine	8006–64–2	100	560	—
Uranium (as U)	7440–61–1			
Soluble compounds		—	0.2	—
Insoluble compounds		—	0.2	—
Vanadium	1314–62–1			
Respirable dust (as V_2O_5)		—	(C)0.5	—
Fume (as V_2O_5)		—	(C)0.1	—
Vegetable oil mist				
Total dust		—	15	—
Respirable fraction		—	5	—
Vinyl benzene; see Styrene.				
Vinyl chloride; see § 1915.1017	75–01–4			
Vinyl cyanide; see Acrylonitrile.				
Vinyl toluene	25013–15–4	100	480	—
Warfarin	81–81–2	—	0.1	—

TABLE Z—SHIPYARDS—Continued

Substance	CAS No.[d]	ppm[a]*	mg/m[3][b]*	Skin Designation
Xylenes (o-, m-, p-isomers)	1330–20–7	100	435	—
Xylidine	1300–73–8	5	25	X
Yttrium	7440–65–5	—	1	—
Zinc chloride fume	7646–85–7	—	1	—
Zinc oxide fume	1314–13–2	—	5	—
Zinc oxide	1314–13–2			
Total dust		—	15	—
Respirable fraction		—	5	—
Zinc stearate	557–05–1			
Total dust		—	15	—
Respirable fraction		—	5	—
Zirconium compounds (as Zr)	7440–67–7	—	5	

MINERAL DUSTS

Substance	mppcf[(j)]
SILICA:	
Crystalline	
Quartz. Threshold Limit calculated from the formula	250[(k)]
	$\%SiO_2+5$
Cristobalite.	
Amorphous, including natural diatomaceous earth	20
SILICATES (less than 1% crystalline silica)	
Mica	20
Portland cement	50
Soapstone	20
Talc (non-asbestiform)	20
Talc (fibrous), use asbestos limit	--
Graphite (natural)	15
Inert or Nuisance Particulates:[(m)]	50 (or 15 mg/m^3 whichever is the smaller) of total dust <1% SiO_2

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

Footnotes to Table Z—Shipyards:
[1] [Reserved]
[2] See Mineral Dusts Table.
[3] Use Asbestos Limit § 1915.1001.
[4] See 1915.1001.
* The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.
[a] Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 760 torr.
[b] Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.
[c] [Reserved]
[d] The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given--not CAS numbers for the individual compounds.
[e–f] [Reserved]
[g] For sectors excluded from § 1915.1028 the limit is 10 ppm TWA.
[h] Where OSHA has published a proposal for a substance but has not issued a final rule, the proposal is referenced and the existing limit is published.
[i] [Reserved]
[j] Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.
[k] The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

[m] Covers all organic and inorganic particulates not otherwise regulated. Same as Particulates Not Otherwise Regulated.

The 1970 TLV uses letter designations instead of a numerical value as follows:

A [1] [Reserved]

A [2] Polytetrafluoroethylene decomposition products. Because these products decompose in part by hydrolysis in alkaline solution, they can be quantitatively determined in air as fluoride to provide an index of exposure. No TLV is recommended pending determination of the toxicity of the products, but air concentrations should be minimal.

A [3] Gasoline and/or Petroleum Distillates. The composition of these materials varies greatly and thus a single TLV for all types of these materials is no longer applicable. The content of benzene, other aromatics and additives should be determined to arrive at the appropriate TLV.

E Simple asphyxiants. The limiting factor is the available oxygen which shall be at least 18% and be within the requirement addressing explosion in subpart B of part 1915.

[58 FR 35514, July 1, 1993, as amended at 61 FR 56856, Nov. 4, 1996; 62 FR 1619, Jan. 10, 1997]

§ 1915.1001 Asbestos.

(a) *Scope and application*. This section regulates asbestos exposure in all shipyard employment work as defined in 29 CFR part 1915, including but not limited to the following:

(1) Demolition or salvage of structures, vessels, and vessel sections where asbestos is present;

(2) Removal or encapsulation of materials containing asbestos;

(3) Construction, alteration, repair, maintenance, or renovation of vessels, vessel sections, structures, substrates, or portions thereof, that contain asbestos;

(4) Installation of products containing asbestos;

(5) Asbestos spill/emergency cleanup; and

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

(7) Coverage under this standard shall be based on the nature of the work operation involving asbestos exposure.

(8) This section does not apply to asbestos-containing asphalt roof cements, coatings and mastics.

(b) *Definitions*.

Aggressive method means removal or disturbance of building/vessel materials by sanding, abrading, grinding, or other method that breaks, crumbles, or otherwise disintegrates intact ACM.

Amended water means water to which surfactant (wetting agent) has been added to increase the ability of the liquid to penetrate ACM.

Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that has been chemically treated and/or altered. For purposes of this standard, *asbestos* includes PACM, as defined below.

Asbestos-containing material, (ACM) means any material containing more than one percent asbestos.

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.

Building/facility/vessel owner is the legal entity, including a lessee, which exercises control over management and record keeping functions relating to a building, facility, and/or vessel in which activities covered by this standard take place.

Certified Industrial Hygienist (CIH) means one certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.

Class I asbestos work means activities involving the removal of thermal system insulation or surfacing ACM/PACM.

Class II asbestos work means activities involving the removal of ACM which is neither TSI or surfacing ACM. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

Class III asbestos work means repair and maintenance operations, where ''ACM'', including TSI and surfacing ACM and PACM, is likely to be disturbed.

Class IV asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean up dust, waste and debris resulting from Class I, II, and III activities.

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

Closely resemble means that the major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.

Competent person see *qualified person*.

Critical barrier means one or more layers of plastic sealed over all openings into a work area or any other physical barrier sufficient to prevent airborne asbestos in a work area from migrating to an adjacent area.

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

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

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

Disturbance means activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM. Disturbance includes cutting away small amounts of ACM and PACM, no greater than the amount which can be contained in one standard sized glove bag or waste bag, in order to access a building or vessel component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or waste bag which shall not exceed 60 inches in length and width.

Employee exposure means that exposure to airborne asbestos that would occur if the employee were not using respiratory protective equipment.

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

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

Glovebag means not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.

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

Homogeneous area means an area of surfacing material or thermal system insulation that is uniform in color and texture.

Industrial hygienist means a professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards.

Intact means that the ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.

Modification for purposes of paragraph (g)(6)(ii) of this section means a changed or altered procedure, material or component of a control system, which replaces a procedure, material or component of a required system. Omitting a procedure or component, or reducing or diminishing the stringency or strength of a material or component of the control system is not a ''modification'' for purposes of paragraph (g)(6) of this section.

Negative Initial Exposure Assessment means a demonstration by the employer, which complies with the criteria in paragraph (f)(2)(iii) of this section, that employee exposure during an operation is expected to be consistently below the PELs.

PACM means *presumed asbestos containing material*.

Presumed asbestos containing material means thermal system insulation and surfacing material found in buildings, vessels, and vessel sections constructed no later than 1980. The designation of a material as ''PACM'' may be rebutted pursuant to paragraph (k)(5) of this section.

Project Designer means a person who has successfully completed the training requirements for an abatement project designer established by 40 U.S.C. §763.90(g).

Qualified person means, in addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and Class II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR part 763) for supervisor, or its equivalent, and for Class III and Class IV work, who is trained in a manner consistent with EPA requirements for training of local education agency maintenance and custodial staff as set forth at 40 CFR 763.92(a)(2).

Regulated area means an area established by the employer to demarcate areas where Class I, II, and III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos, exceed or can reasonably be expected to exceed the permissible exposure limit. Requirements for regulated areas are set out in paragraph (e) of this section.

Removal means all operations where ACM and/or PACM is taken out or stripped from structures or substrates, and includes demolition operations.

Renovation means the modifying of any existing vessel, vessel section, structure, or portion thereof.

Repair means overhauling, rebuilding, reconstructing, or reconditioning of vessels, vessel sections, structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.

Surfacing material means material that is sprayed, troweled-on or otherwise applied to surfaces (such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, and other purposes).

Surfacing ACM means surfacing material which contains more than 1% asbestos.

Thermal system insulation (TSI) means ACM applied to pipes, fittings, boilers, breeching, tanks, ducts or other structural components to prevent heat loss or gain.

Thermal system insulation ACM is thermal system insulation which contains more than 1% asbestos.

(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 0.1 fiber per cubic centimeter of air as an eight (8) hour time-weighted average (TWA), as determined by the method prescribed in appendix A to 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, as determined by the method prescribed in appendix A to this section, or by an equivalent method.

(d) *Multi-employer worksites.* (1) On multi-employer worksites, an employer performing work requiring the establishment of a regulated area shall inform other employers on the site of the nature of the employer's work with asbestos and/or PACM, of the existence of and requirements pertaining to regulated areas, and the measures taken to ensure that employees of such other employers are not exposed to asbestos.

(2) Asbestos hazards at a multi-employer work site shall be abated by the contractor who created or controls the source of asbestos contamination. For example, if there is a significant breach of an enclosure containing Class I work, the employer responsible for erecting the enclosure shall repair the breach immediately.

(3) In addition, all employers of employees exposed to asbestos hazards shall comply with applicable protective provisions to protect their employees. For example, if employees working immediately adjacent to a Class I asbestos job are exposed to asbestos due to the inadequate containment of such job, their employer shall either remove the employees from the area until the enclosure breach is repaired; or perform an initial exposure assessment pursuant to paragraph (f) of this section.

(4) All employers of employees working adjacent to regulated areas established by another employer on a multi-employer work- site, shall take steps on a daily basis to ascertain the integrity of the enclosure and/or the effectiveness of the control method relied on by the primary asbestos contractor to assure that asbestos fibers do not migrate to such adjacent areas.

(5) All general contractors on a shipyard project which includes work covered by this standard shall be deemed to exercise general supervisory authority over the work covered by this standard, even though the general contractor is not qualified to serve as the asbestos ''qualified person'' as defined by paragraph (b) of this section. As supervisor of the entire project, the general contractor shall ascertain whether the asbestos contractor is in compliance with this standard, and shall require such contractor to come into compliance with this standard when necessary.

(e) *Regulated areas.* (1) All Class I, II and III asbestos work shall be conducted within regulated areas. All other operations covered by this standard shall be conducted within a regulated area where airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed a PEL. Regulated areas shall comply with the requirements of paragraphs (e) (2), (3), (4) and (5) of this section.

(2) *Demarcation.* The regulated area shall be demarcated in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they may demarcate the regulated area. Signs shall be provided and displayed pursuant to the requirements of paragraph (k)(7) of this section.

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

(4) *Respirators.* All persons entering a regulated area where employees are required pursuant to paragraph (h)(1) of this section to wear respirators shall be supplied with a respirator selected in accordance with paragraph (h)(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 area.

(6) *Qualified persons.* The employer shall ensure that all asbestos work performed within regulated areas is supervised by a qualified person, as defined in paragraph (b) of this section. The duties of the qualified person are set out in paragraph (o) of this section.

(f) *Exposure assessments and monitoring*—(1) *General monitoring criteria.* (i) Each employer who has a workplace or work operation where exposure monitoring is required under this section shall perform monitoring to determine accurately the airborne concentrations of asbestos to which employees may be exposed.

(ii) 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.

(iii) Representative 8-hour TWA employee exposure shall be determined on the basis of one or more samples representing full-shift exposure for employees 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 employees in each work area.

(2) *Initial exposure assessment.* (i) Each employer who has a workplace or work operation covered by this standard shall ensure that a ''qualified person'' conducts an exposure assessment immediately before or at the initiation of

the operation to ascertain expected exposures during that operation or workplace. The assessment must be completed in time to comply with requirements which are triggered by exposure data or the lack of a ''negative exposure assessment,'' and to provide information necessary to assure that all control systems planned are appropriate for that operation and will work properly.

(ii) *Basis of initial exposure assessment.* Unless a negative exposure assessment has been made pursuant to paragraph (f)(2)(iii) of this section, the initial exposure assessment shall, if feasible, be based on monitoring conducted pursuant to paragraph (f)(1)(iii) of this section. The assessment shall take into consideration both the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the employer which indicate the levels of airborne asbestos likely to be encountered on the job. For Class I asbestos work, until the employer conducts exposure monitoring and documents that employees on that job will not be exposed in excess of the PELs, or otherwise makes a negative exposure assessment pursuant to paragraph (f)(2)(iii) of this section, the employer shall presume that employees are exposed in excess of the TWA and excursion limit.

(iii) *Negative initial exposure assessment.* For any one specific asbestos job which will be performed by employees who have been trained in compliance with the standard, the employer may demonstrate that employee exposures will be below the PELs by data which conform to the following criteria:

(A) Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the TWA and excursion limit under those work conditions having the greatest potential for releasing asbestos; or

(B) Where the employer has monitored prior asbestos jobs for the PEL and the excursion limit within 12 months of the current or projected job, the monitoring and analysis were performed in compliance with the asbestos standard in effect; and the data were obtained during work operations conducted under workplace conditions ''closely resembling'' the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations, the operations were conducted by employees whose training and experience are no more extensive than that of employees performing the current job, and these data show that under the conditions prevailing and which will prevail in the current workplace there is a high degree of certainty that employee exposures will not exceed the TWA and excursion limit; or

(C) The results of initial exposure monitoring of the current job made from breathing zone air samples that are representative of the 8-hour TWA and 30-minute short-term exposures of each employee covering operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

(3) *Periodic monitoring*—(i) *Class I and II operations.* The employer shall conduct daily monitoring that is representative of the exposure of each employee who is assigned to work within a regulated area who is performing Class I or II work, unless the employer pursuant to paragraph (f)(2)(iii) of this section, has made a negative exposure assessment for the entire operation.

(ii) *All operations under the standard other than Class I and II operations.* The employer shall conduct periodic monitoring of all work where exposures are expected to exceed a PEL, at intervals sufficient to document the validity of the exposure prediction.

(iii) *Exception.* When all employees required to be monitored daily are equipped with supplied-air respirators operated in the pressure demand mode, or other positive pressure mode respirator, the employer may dispense with the daily monitoring required by this paragraph. However, employees performing Class I work using a control method which is not listed in paragraph (g)(4) (i), (ii), or (iii) of this section or using a modification of a listed control method, shall continue to be

monitored daily even if they are equipped with supplied-air respirators.

(4) *Termination of monitoring.* (i) If the periodic monitoring required by paragraph (f)(3) of this section reveals that employee exposures, as indicated by statistically reliable measurements, are below the permissible exposure limit and excursion limit the employer may discontinue monitoring for those employees whose exposures are represented by such monitoring.

(ii) *Additional monitoring.* Notwithstanding the provisions of paragraph (f)(2) and (3), and (f)(4) of this section, the employer shall institute the exposure monitoring required under paragraph (f)(3) of this section whenever there has been a change in process, control equipment, personnel or work practices that may result in new or additional exposures above the permissible exposure limit 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 permissible exposure limit and/or excursion limit. Such additional monitoring is required regardless of whether a ''negative exposure assessment'' was previously produced for a specific job.

(5) *Employee notification of monitoring results.* (i) The employer shall notify affected employees of the monitoring results that represent that employee's exposure as soon as possible following receipt of monitoring results.

(ii) The employer shall notify affected employees of the results of monitoring representing the employee's exposure in writing either individually or by posting at a centrally located place that is accessible to affected employees.

(6) *Observation of monitoring.* (i) The employer shall provide affected employees and their designated representatives an opportunity to observe any monitoring of employee exposure to asbestos conducted in accordance with this section.

(ii) 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.

(g) *Methods of compliance*—(1) *Engineering controls and work practices for all operations covered by this section.* The employer shall use the following engineering controls and work practices in all operations covered by this section, regardless of the levels of exposure:

(i) Vacuum cleaners equipped with HEPA filters to collect all debris and dust containing ACM and PACM, except as provided in paragraph (g)(8)(ii) of this section in the case of roofing material;

(ii) Wet methods, or wetting agents, to control employee exposures during asbestos handling, mixing, removal, cutting, application, and cleanup, except where employers demonstrate that the use of wet methods is infeasible due to for example, the creation of electrical hazards, equipment malfunction, and, in roofing, except as provided in paragraph (g)(8)(ii) of this section; and

(iii) Prompt clean-up and disposal of wastes and debris contaminated with asbestos in leak-tight containers except in roofing operations, where the procedures specified in paragraph (g)(8)(ii) of this section apply.

(2) In addition to the requirements of paragraph (g)(1) of this section above, the employer shall use the following control methods to achieve compliance with the TWA permissible exposure limit and excursion limit prescribed by paragraph (c) of this section;

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

(ii) Enclosure or isolation of processes producing asbestos dust;

(iii) Ventilation of the regulated area to move contaminated air away from the breathing zone of employees and toward a filtration or collection device equipped with a HEPA filter;

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

(v) Wherever the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the permissible exposure limit and/or excursion limit prescribed in paragraph (c) of this section, the employer shall use them to

reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (h) of this section.

(3) *Prohibitions.* The following work practices and engineering controls shall not be used for work related to asbestos or for work which disturbs ACM or PACM, regardless of measured levels of asbestos exposure or the results of initial exposure assessments:

(i) High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

(ii) Compressed air used to remove asbestos, or materials containing asbestos, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

(iii) Dry sweeping, shoveling or other dry clean-up of dust and debris containing ACM and PACM.

(iv) Employee rotation as a means of reducing employee exposure to asbestos.

(4) *Class I requirements.* In addition to the provisions of paragraphs (g) (1) and (2) of this section, the following engineering controls and work practices and procedures shall be used.

(i) All Class I work, including the installation and operation of the control system shall be supervised by a qualified person as defined in paragraph (b) of this section;

(ii) For all Class I jobs involving the removal of more than 25 linear or 10 square feet of TSI or surfacing ACM or PACM; for all other Class I jobs, where the employer cannot produce a negative exposure assessment pursuant to paragraph (f)(2)(iii) of this section, or where employees are working in areas adjacent to the regulated area, while the Class I work is being performed, the employer shall use one of the following methods to ensure that airborne asbestos does not migrate from the regulated area:

(A) Critical barriers shall be placed over all the openings to the regulated area, except where activities are performed outdoors; or

(B) The employer shall use another barrier or isolation method which prevents the migration of airborne asbestos from the regulated area, as verified by perimeter area surveillance during each work shift at each boundary of the regulated area, showing no visible asbestos dust; and perimeter area monitoring showing that clearance levels contained in 40 CFR part 763, subpart E of the EPA Asbestos in Schools Rule are met, or that perimeter area levels, measured by Phase Contrast Microscopy (PCM) are no more than background levels representing the same area before the asbestos work began. The results of such monitoring shall be made known to the employer no later than 24 hours from the end of the work shift represented by such monitoring. Exception: For work completed outdoors where employees are not working in areas adjacent to the regulated areas, this paragraph (g)(4)(ii) is satisfied when the specific control methods in paragraph (g)(5) of this section are used.

(iii) For all Class I jobs, HVAC systems shall be isolated in the regulated area by sealing with a double layer of 6 mil plastic or the equivalent;

(iv) For all Class I jobs, impermeable dropcloths shall be placed on surfaces beneath all removal activity;

(v) For all Class I jobs, all objects within the regulated area shall be covered with impermeable dropcloths or plastic sheeting which is secured by duct tape or an equivalent.

(vi) For all Class I jobs where the employer cannot produce a negative exposure assessment or where exposure monitoring shows the PELs are exceeded, the employer shall ventilate the regulated area to move contaminated air away from the breathing zone of employees toward a HEPA filtration or collection device.

(5) *Specific control systems for Class I work.* In addition, Class I asbestos work shall be performed using one or more of the following control methods pursuant to the limitations stated below:

(i) *Negative pressure enclosure (NPE) systems.* NPE systems may be used where the configuration of the work area does not make the erection of the enclosure infeasible, with the following specifications and work practices.

(A) *Specifications*—(*1*) The negative pressure enclosure (NPE) may be of any configuration,

(*2*) At least 4 air changes per hour shall be maintained in the NPE,

(*3*) A minimum of −0.02 column inches of water pressure differential, relative to outside pressure, shall be maintained within the NPE as evidenced by manometric measurements,

(*4*) The NPE shall be kept under negative pressure throughout the period of its use, and

(*5*) Air movement shall be directed away from employees performing asbestos work within the enclosure, and toward a HEPA filtration or a collection device.

(B) *Work practices*—(*1*) Before beginning work within the enclosure and at the beginning of each shift, the NPE shall be inspected for breaches and smoke-tested for leaks, and any leaks sealed.

(*2*) Electrical circuits in the enclosure shall be deactivated, unless equipped with ground-fault circuit interrupters.

(ii) Glove bag systems may be used to remove PACM and/or ACM from straight runs of piping and elbows and other connections with the following specifications and work practices:

(A) *Specifications*—(*1*) Glovebags shall be made of 6 mil thick plastic and shall be seamless at the bottom.

(*2*) Glovebags used on elbows and other connections must be designed for that purpose and used without modifications.

(B) *Work practices*—(*1*) Each glovebag shall be installed so that it completely covers the circumference of pipe or other structure where the work is to be done.

(*2*) Glovebags shall be smoke-tested for leaks and any leaks sealed prior to use.

(*3*) Glovebags may be used only once and may not be moved.

(*4*) Glovebags shall not be used on surfaces whose temperature exceeds 150 °F.

(*5*) Prior to disposal, glovebags shall be collapsed by removing air within them using a HEPA vacuum.

(*6*) Before beginning the operation, loose and friable material adjacent to the glovebag/box operation shall be wrapped and sealed in two layers of six mil plastic or otherwise rendered intact.

(*7*) Where system uses attached waste bag, such bag shall be connected to collection bag using hose or other material which shall withstand pressure of ACM waste and water without losing its integrity:

(*8*) Sliding valve or other device shall separate waste bag from hose to ensure no exposure when waste bag is disconnected:

(*9*) At least two persons shall perform Class I glovebag removal operations.

(iii) *Negative pressure glove bag systems*. Negative pressure glove bag systems may be used to remove ACM or PACM from piping.

(A) *Specifications*. In addition to specifications for glove bag systems above, negative pressure glove bag systems shall attach HEPA vacuum system or other device to bag to prevent collapse during removal.

(B) *Work practices*—(*1*) The employer shall comply with the work practices for glove bag systems in paragraph (g)(5)(ii)(B)(4) of this section,

(*2*) The HEPA vacuum cleaner or other device used to prevent collapse of bag during removal shall run continually during the operation until it is completed at which time the bag shall be collapsed prior to removal of the bag from the pipe.

(*3*) Where a separate waste bag is used along with a collection bag and discarded after one use, the collection bag may be reused if rinsed clean with amended water before reuse.

(iv) *Negative pressure glove box systems*. Negative pressure glove boxes may be used to remove ACM or PACM from pipe runs with the following specifications and work practices.

(A) *Specifications*—(*1*) Glove boxes shall be constructed with rigid sides and made from metal or other material which can withstand the weight of the ACM and PACM and water used during removal:

(*2*) A negative pressure generator shall be used to create negative pressure in the system:

(*3*) An air filtration unit shall be attached to the box:

(*4*) The box shall be fitted with gloved apertures:

(*5*) An aperture at the base of the box shall serve as a bagging outlet for waste ACM and water:

(*6*) A back-up generator shall be present on site:

(*7*) Waste bags shall consist of 6 mil thick plastic double-bagged before they are filled or plastic thicker than 6 mil.

(B) *Work practices*—(*1*) At least two persons shall perform the removal:

(*2*) The box shall be smoke-tested for leaks and any leaks sealed prior to each use.

(*3*) Loose or damaged ACM adjacent to the box shall be wrapped and sealed in two layers of 6 mil plastic prior to the job, or otherwise made intact prior to the job.

(*4*) A HEPA filtration system shall be used to maintain pressure barrier in box.

(v) *Water spray process system.* A water spray process system may be used for removal of ACM and PACM from cold line piping if, employees carrying out such process have completed a 40-hour separate training course in its use, in addition to training required for employees performing Class I work. The system shall meet the following specifications and shall be performed by employees using the following work practices.

(A) *Specifications*—(*1*) Piping from which insulation will be removed shall be surrounded on 3 sides by rigid framing,

(*2*) A 360 degree water spray, delivered through nozzles supplied by a high pressure separate water line, shall be formed around the piping.

(*3*) The spray shall collide to form a fine aerosol which provides a liquid barrier between workers and the ACM and PACM.

(B) *Work practices*—(*1*) The system shall be run for at least 10 minutes before removal begins.

(*2*) All removal shall take place within the barrier.

(*3*) The system shall be operated by at least three persons, one of whom shall not perform removal but shall check equipment, and ensure proper operation of the system.

(*4*) After removal, the ACM and PACM shall be bagged while still inside the water barrier.

(vi) A small walk-in enclosure which accommodates no more than two persons (mini-enclosure) may be used if the disturbance or removal can be completely contained by the enclosure, with the following specifications and work practices.

(A) *Specifications*—(*1*) The fabricated or job-made enclosure shall be constructed of 6 mil plastic or equivalent:

(*2*) The enclosure shall be placed under negative pressure by means of a HEPA filtered vacuum or similar ventilation unit:

(B) *Work practices*—(*1*) Before use, the mini-enclosure shall be inspected for leaks and smoketested to detect breaches, and any breaches sealed.

(*2*) Before reuse, the interior shall be completely washed with amended water and HEPA-vacuumed.

(*3*) During use, air movement shall be directed away from the employee's breathing zone within the mini-enclosure.

(6) *Alternative control methods for Class I work.* Class I work may be performed using a control method which is not referenced in paragraph (g)(5) of this section, or which modifies a control method referenced in paragraph (g)(5) of this section, if the following provisions are complied with:

(i) The control method shall enclose, contain or isolate the processes or source of airborne asbestos dust, or otherwise capture or redirect such dust before it enters the breathing zone of employees.

(ii) A certified industrial hygienist or licensed professional engineer who is also qualified as a project designer as defined in paragraph (b) of this section, shall evaluate the work area, the projected work practices and the engineering controls and shall certify in writing that: the planned control method is adequate to reduce direct and indirect employee exposure to below the PELs under worst-case conditions of use, and that the planned control method will prevent asbestos contamination outside the regulated area, as measured by clearance sampling which meets the requirements of EPA's Asbestos in Schools Rule issued under AHERA, or perimeter monitoring which meets the criteria in paragraph (g)(4)(ii)(B) of this section.

(A) Where the TSI or surfacing material to be removed is 25 linear or 10 square feet or less , the evaluation required in paragraph (g)(6) of this section may be performed by a ''qualified person'', and may omit consideration of perimeter or clearance monitoring otherwise required.

(B) The evaluation of employee exposure required in paragraph (g)(6) of this section, shall include and be based on sampling and analytical data representing employee exposure during the use of such method under worst-case conditions and by employees whose training and experience are equivalent to employees who are to perform the current job.

(iii) Before work which involves the removal of more than 25 linear or 10 square feet of TSI or surfacing ACM/PACM is begun using an alternative method which has been the subject of a paragraph (g)(6) of this section required evaluation and certification, the employer shall send a copy of such evaluation and certification to the national office of OSHA, Office of Technical Support, Room N3653, 200 Constitution Avenue, NW, Washington, DC 20210. The submission shall not constitute approval by OSHA.

(7) *Work practices and engineering controls for Class II work.* (i) All Class II work shall be supervised by a qualified person as defined in paragraph (b) of this section.

(ii) For all indoor Class II jobs, where the employer has not produced a negative exposure assessment pursuant to paragraph (f)(2)(iii) of this section, or where during the job, changed conditions indicate there may be exposure above the PEL or where the employer does not remove the ACM in a substantially intact state, the employer shall use one of the following methods to ensure that airborne asbestos does not migrate from the regulated area;

(A) Critical barriers shall be placed over all openings to the regulated area; or,

(B) The employer shall use another barrier or isolation method which prevents the migration of airborne asbestos from the regulated area, as verified by perimeter area monitoring or clearance monitoring which meets the criteria set out in paragraph (g)(4)(ii)(B) of this section.

(C) Impermeable dropcloths shall be placed on surfaces beneath all removal activity;

(iii) [Reserved]

(iv) All Class II asbestos work shall be performed using the work practices and requirements set out above in paragraph (g)(1)(i) through (g)(1)(iii) of this section.

(8) *Additional controls for Class II work.* Class II asbestos work shall also be performed by complying with the work practices and controls designated for each type of asbestos work to be performed, set out in this paragraph. Where more than one control method may be used for a type of asbestos work, the employer may choose one or a combination of designated control methods. Class II work also may be performed using a method allowed for Class I work, except that glove bags and glove boxes are allowed if they fully enclose the Class II material to be removed.

(i) For removing vinyl and asphalt flooring/deck materials which contain ACM or for which in buildings constructed not later than 1980, the employer has not verified the absence of ACM pursuant to paragraph (g)(8)(i)(I): the employer shall ensure that employees comply with the following work practices and that employees are trained in these practices pursuant to paragraph (k)(9) of this section:

(A) Flooring/deck materials or its backing shall not be sanded.

(B) Vacuums equipped with HEPA filter, disposable dust bag, and metal floor tool (no brush) shall be used to clean floors.

(C) Resilient sheeting shall be removed by cutting with wetting of the snip point and wetting during delamination. Rip-up of resilient sheet floor material is prohibited.

(D) All scraping of residual adhesive and/or backing shall be performed using wet methods.

(E) Dry sweeping is prohibited.

(F) Mechanical chipping is prohibited unless performed in a negative pressure enclosure which meets the requirements of paragraph (g)(5)(i) of this section.

(G) Tiles shall be removed intact, unless the employer demonstrates that intact removal is not possible.

(H) When tiles are heated and can be removed intact, wetting may be omitted.

(I) Resilient flooring/deck material in buildings/vessels constructed no later than 1980, including associated mastic and backing shall be assumed to be asbestos-containing unless an industrial hygienist determines that it is asbestos-free using recognized analytical techniques.

(ii) For removing roofing material which contains ACM the employer shall ensure that the following work practices are followed:

(A) Roofing material shall be removed in an intact state to the extent feasible.

(B) Wet methods shall be used to remove roofing materials that are not intact, or that will be rendered not intact during removal, unless such wet methods are not feasible or will create safety hazards.

(C) Cutting machines shall be continuously misted during use, unless a competent person determines that misting substantially decreases worker safety.

(D) When removing built-up roofs with asbestos-containing roofing felts and an aggregate surface using a power roof cutter, all dust resulting from the cutting operation shall be collected by a HEPA dust collector, or shall be HEPA vacuumed by vacuuming along the cut line. When removing built-up roofs with asbestos-containing roofing felts and a smooth surface using a power roof cutter, the dust resulting from the cutting operation shall be collected either by a HEPA dust collector or HEPA vacuuming along the cut line, or by gently sweeping and then carefully and completely wiping up the still-wet dust and debris left along the cut line. The dust and debris shall be immediately bagged or placed in covered containers.

(E) Asbestos-containing material that has been removed from a roof shall not be dropped or thrown to the ground. Unless the material is carried or passed to the ground by hand, it shall be lowered to the ground via covered, dust-tight chute, crane or hoist:

(*1*) Any ACM that is not intact shall be lowered to the ground as soon as is practicable, but in any event no later than the end of the work shift. While the material remains on the roof it shall either be kept wet, placed in an impermeable waste bag, or wrapped in plastic sheeting.

(*2*) Intact ACM shall be lowered to the ground as soon as is practicable, but in any event no later than the end of the work shift.

(F) Upon being lowered, unwrapped material shall be transferred to a closed receptacle in such manner so as to preclude the dispersion of dust.

(G) Roof level heating and ventilation air intake sources shall be isolated or the ventilation system shall be shut down.

(H) Notwithstanding any other provision of this section, removal or repair of sections of intact roofing less than 25 square feet in area does not require use of wet methods or HEPA vacuuming as long as manual methods which do not render the material non-intact are used to remove the material and no visible dust is created by the removal method used. In determining whether a job involves less than 25 square feet, the employer shall include all removal and repair work performed on the same roof on the same day.

(iii) When removing cementitious asbestos-containing siding and shingles or transite panels containing ACM on building exteriors (other than roofs, where paragraph (g)(8)(ii) of this section applies) the employer shall ensure that the following work practices are followed:

(A) Cutting, abrading or breaking siding, shingles, or transite panels shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release cannot be used.

(B) Each panel or shingle shall be sprayed with amended water prior to removal.

(C) Unwrapped or unbagged panels or shingles shall be immediately lowered to the ground via covered dust-tight chute, crane or hoist, or placed in an impervious waste bag or wrapped in plastic sheeting and lowered to the ground no later than the end of the work shift.

(D) Nails shall be cut with flat, sharp instruments.

(iv) When removing gaskets containing ACM, the employer shall ensure that the following work practices are followed:

(A) If a gasket is visibly deteriorated and unlikely to be removed intact, removal shall be undertaken within a glovebag as described in paragraph (g)(5)(ii) of this section.

(B) [Reserved]

(C) The gasket shall be immediately placed in a disposal container.

(D) Any scraping to remove residue must be performed wet.

(v) When performing any other Class II removal of asbestos containing material for which specific controls have not been listed in paragraph (g)(8)(iv) (A) through (D) of this section, the employer shall ensure that the following work practices are complied with.

(A) The material shall be thoroughly wetted with amended water prior to and during its removal.

(B) The material shall be removed in an intact state unless the employer demonstrates that intact removal is not possible.

(C) Cutting, abrading or breaking the material shall be prohibited unless the employer can demonstrate that methods less likely to result in asbestos fiber release are not feasible.

(D) Asbestos-containing material removed, shall be immediately bagged or wrapped, or kept wetted until transferred to a closed receptacle, no later than the end of the work shift.

(vi) *Alternative work practices and controls.* Instead of the work practices and controls listed in paragraphs (g)(8) (i) through (v) of this section, the employer may use different or modified engineering and work practice controls if the following provisions are complied with.

(A) The employer shall demonstrate by data representing employee exposure during the use of such method under conditions which closely resemble the conditions under which the method is to be used, that employee exposure will not exceed the PELs under any anticipated circumstances.

(B) A qualified person shall evaluate the work area, the projected work practices and the engineering controls, and shall certify in writing, that the different or modified controls are adequate to reduce direct and indirect employee exposure to below the PELs under all expected conditions of use and that the method meets the requirements of this standard. The evaluation shall include and be based on data representing employee exposure during the use of such method under conditions which closely resemble the conditions under which the method is to be used for the current job, and by employees whose training and experience are equivalent to employees who are to perform the current job.

(9) *Work practices and engineering controls for Class III asbestos work.* Class III asbestos work shall be conducted using engineering and work practice controls which minimize the exposure to employees performing the asbestos work and to bystander employees.

(i) The work shall be performed using wet methods.

(ii) To the extent feasible, the work shall be performed using local exhaust ventilation.

(iii) Where the disturbance involves drilling, cutting, abrading, sanding, chipping, breaking, or sawing of thermal system insulation or surfacing material, the employer shall use impermeable dropcloths and shall isolate the operation using mini-enclosures or glove bag systems pursuant to paragraph (g)(5) of this section or another isolation method.

(iv) Where the employer does not demonstrate by a negative exposure assessment performed in compliance with paragraph (f)(2)(iii) of this section that the PELs will not be exceeded, or where monitoring results show exceedances of a PEL, the employer shall contain the area using impermeable dropcloths and plastic barriers or their equivalent, or shall isolate the operation using mini-enclosure or glove bag systems pursuant to paragraph (g)(5) of this section.

(v) Employees performing Class III jobs which involve the disturbance of TSI or surfacing ACM or PACM or where the employer does not demonstrate by a ''negative exposure assessment'' in compliance with paragraph (f)(2)(iii) of this section that the PELs will not be exceeded or where

monitoring results show exceedances of the PEL, shall wear respirators which are selected, used and fitted pursuant to provisions of paragraph (h) of this section.

(10) *Class IV asbestos work.* Class IV asbestos jobs shall be conducted by employees trained pursuant to the asbestos awareness training program set out in paragraph (k)(9) of this section. In addition, all Class IV jobs shall be conducted in conformity with the requirements set out in paragraph (g)(1) of this section, mandating wet methods, HEPA vacuums, and prompt clean up of debris containing ACM or PACM.

(i) Employees cleaning up debris and waste in a regulated area where respirators are required shall wear respirators which are selected, used and fitted pursuant to provisions of paragraph (h) of this section.

(ii) Employers of employees cleaning up waste and debris in an area where friable TSI or surfacing ACM/PACM is accessible, shall assume that such waste and debris contain asbestos.

(11) *Specific compliance methods for brake and clutch repair*—(i) *Engineering controls and work practices for brake and clutch repair and service.* During automotive brake and clutch inspection, disassembly, repair and assembly operations, the employer shall institute engineering controls and work practices to reduce employee exposure to materials containing asbestos using a negative pressure enclosure/HEPA vacuum system method or low pressure/wet cleaning method, which meets the detailed requirements set out in appendix L to this section. The employer may also comply using an equivalent method which follows written procedures which the employer demonstrates can achieve results equivalent to Method A. For facilities in which no more than 5 pair of brakes or 5 clutches are inspected, disassembled, repaired, or assembled per week, the method set for in paragraph [D] of appendix L to this section may be used.

(ii) The employer may also comply by using an equivalent method which follows written procedures, which the employer demonstrates can achieve equivalent exposure reductions as do the two ''preferred methods.'' Such demonstration must include monitoring data conducted under workplace conditions closely resembling the process, type of asbestos containing materials, control method, work practices and environmental conditions which the equivalent method will be used, or objective data, which document that under all reasonably foreseeable conditions of brake and clutch repair applications, the method results in exposures which are equivalent to the methods set out in appendix L to this section.

(12) *Alternative methods of compliance for installation, removal, repair, and maintenance of certain roofing and pipeline coating materials.* Notwithstanding any other provision of this section, an employer who complies with all provisions of this paragraph (g)(12) when installing, removing, repairing, or maintaining intact pipeline asphaltic wrap, or roof flashings which contain asbestos fibers encapsulated or coated by bituminous or resinous compounds shall be deemed to be in compliance with this section. If an employer does not comply with all provisions of this paragraph (g)(12) or if during the course of the job the material does not remain intact, the provisions of paragraph (g)(8) of this section apply instead of this paragraph (g)(12).

(i) Before work begins and as needed during the job, a qualified person who is capable of identifying asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, and who has the authority to take prompt corrective measures to eliminate such hazards, shall conduct an inspection of the worksite and determine that the roofing material is intact and will likely remain intact.

(ii) All employees performing work covered by this paragraph (g)(12) shall be trained in a training program that meets the requirements of paragraph (k)(9)(viii) of this section.

(iii) The material shall not be sanded, abraded, or ground. Manual methods which do not render the material non-intact shall be used.

(iv) Material that has been removed from a roof shall not be dropped or thrown to the ground. Unless the material is carried or passed to the ground by hand, it shall be lowered to the ground via covered, dust-tight chute,

crane or hoist. All such material shall be removed from the roof as soon as is practicable, but in any event no later than the end of the work shift.

(v) Where roofing products which have been labeled as containing asbestos pursuant to paragraph (k)(8) of this section are installed on non-residential roofs during operations covered by this paragraph (g)(12), the employer shall notify the building owner of the presence and location of such materials no later than the end of the job.

(vi) All removal or disturbance of pipeline asphaltic wrap shall be performed using wet methods.

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

(i) During all Class I asbestos jobs.

(ii) During all Class II work where the ACM is not removed in a substantially intact state.

(iii) During all Class II and III work which is not performed using wet methods, provided, however, that respirators need not be worn during removal of ACM from sloped roofs when a negative exposure assessment has been made and the ACM is removed in an intact state.

(iv) During all Class II and III asbestos jobs where the employer does not produce a ''negative exposure assessment''.

(v) During all Class III jobs where TSI or surfacing ACM or PACM is being disturbed.

(vi) During all Class IV work performed within regulated areas where employees performing other work are required to wear respirators.

(vii) During all work covered by this section where employees are exposed above the TWA or excursion limit.

(viii) In emergencies.

(2) *Respirator selection.* (i) Where respirators are used, the employer shall select and provide, at no cost to the employee, the appropriate respirator as specified in table 1, or in paragraph (h)(2)(iii) of this section, and shall ensure that the employee uses the respirator provided.

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

(iii)(A) The employer shall provide a tight fitting powered, air-purifying respirator in lieu of any negative-pressure respirator specified in table 1 whenever:

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

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

(B) The employer shall inform any employee required to wear a respirator under this paragraph that the employee may require the employer to provide a powered, air-purifying respirator in lieu of a negative pressure respirator.

TABLE 1—RESPIRATORY PROTECTION FOR ASBESTOS FIBERS

Airborne concentration of asbestos or conditions of use	Required respirator
Not in excess of 1 f/cc (10) X PEL), or otherwise as required independent of exposure pursuant to paragraph (h)(2)(iv) of this section.	Half-mask air purifying respirator other than a disposable respirator, equipped with high efficiency filters.
Not in excess of 5 f/cc (50 X PEL)	Full facepiece air-purifying respirator equipped with high efficiency filters.
Not in excess of 10 f/cc (100 X PEL)	Any powered air-purifying respirator equipped with high efficiency filters or any supplied air respirator operated in continuous flow mode.
Not in excess of 100 f/cc (1,000 X PEL)	Full facepiece supplied air respirator operated in pressure demand mode.
Greater than 100 f/cc (1,000 X PEL) or unknown concentration.	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 high environmental concentrations may be used at lower concentrations, or when required respirator use is independent of concentration.

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

(iv) In addition to the above selection criterion, the employer shall provide a half-mask air purifying respirator, other than a disposable respirator, equipped with high efficiency filters whenever the employee performs the following activities: Class II and III asbestos jobs where the employer does not produce a negative exposure assessment; and Class III jobs where TSI or surfacing ACM or PACM is being disturbed.

(v) In addition to the selection criteria in paragraph (h)(2)(i) through (iv), the employer shall provide a tight-fitting powered air purifying respirator equipped with high efficiency filters or a full facepiece supplied air respirator operated in the pressure demand mode equipped with HEPA egress cartridges or an auxiliary positive pressure self-contained breathing apparatus for all employees within the regulated area where Class I work is being performed for which a negative exposure assessment has not been produced and, the exposure assessment indicates the exposure level will not exceed 1 f/cc as an 8-hour time weighted average. A full facepiece supplied air respirator operated in the pressure demand mode equipped with an auxiliary positive pressure self-contained breathing apparatus shall be provided under such conditions, if the exposure assessment indicates exposure levels above 1 f/cc as an 8-hour time weighted average.

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

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

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

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

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

(ii) Employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every 6 months thereafter for each employee wearing a negative-pressure respirator. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, or of full-facepiece air purifying respirators where they are worn at levels at which half-facepiece air purifying respirators are permitted. Qualitative and quantitative fit tests shall be conducted in accordance with appendix C to this section. The tests shall be used to select facepieces that provide the required protection as prescribed in table 1, in paragraph (h)(2)(i) of this section.

(i) *Protective clothing*—(1) *General.* The employer shall provide and require the use of protective clothing, such as coveralls or similar whole-body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos that exceed the TWA and/or excursion limit prescribed in paragraph (c) of this section, or for which a required negative exposure assessment is not produced, or for any employee performing Class I operations which involve the removal of over 25 linear or 10 square feet of TSI or surfacing ACM or PACM.

(2) *Laundering.* (i) The employer shall ensure that laundering of contaminated clothing is done so as to prevent

the release of airborne asbestos in excess of the TWA or excursion limit prescribed in paragraph (c) of this section.

(ii) Any employer who gives contaminated clothing to another person for laundering shall inform such person of the requirement in paragraph (i)(2)(i) of this section to effectively prevent the release of airborne asbestos in excess of the TWA excursion limit prescribed in paragraph (c) of this section.

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

(4) *Inspection of protective clothing.* (i) The qualified person shall examine worksuits worn by employees at least once per workshift for rips or tears that may occur during performance of work.

(ii) When rips or tears are detected while an employee is working, rips and tears shall be immediately mended, or the worksuit shall be immediately replaced.

(j) *Hygiene facilities and practices for employees.* (1) Requirements for employees performing Class I asbestos jobs involving over 25 linear or 10 square feet of TSI or surfacing ACM and PACM.

(i) *Decontamination areas.* For all Class I jobs involving over 25 linear or 10 square feet of TSI or surfacing ACM or PACM, the employer shall establish a decontamination area that is adjacent and connected to the regulated area for the decontamination of such employees. The decontamination area shall consist of an equipment room, shower area, and clean room in series. The employer shall ensure that employees enter and exit the regulated area through the decontamination area.

(A) *Equipment room.* The equipment room shall be supplied with impermeable, labeled bags and containers for the containment and disposal of contaminated protective equipment.

(B) *Shower area.* Shower facilities shall be provided which comply with 29 CFR 1910.141(d)(3), unless the employer can demonstrate that they are not feasible. The showers shall be adjacent both to the equipment room and the clean room, unless the employer can demonstrate that this location is not feasible. Where the employer can demonstrate that it is not feasible to locate the shower between the equipment room and the clean room, or where the work is performed outdoors, or when the work involving asbestos exposure takes place on board a ship, the employers shall ensure that employees:

(*1*) Remove asbestos contamination from their worksuits in the equipment room using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or

(*2*) Remove their contaminated worksuits in the equipment room, then don clean worksuits, and proceed to a shower that is not adjacent to the work area.

(C) *Clean change room.* The clean room shall be equipped with a locker or appropriate storage container for each employee's use. When the employer can demonstrate that it is not feasible to provide a clean change area adjacent to the work area, or where the work is performed outdoors, or when the work takes place aboard a ship, the employer may permit employees engaged in Class I asbestos jobs to clean their protective clothing with a portable HEPA-equipped vacuum before such employees leave the regulated area. Following showering, such employees however must then change into street clothing in clean change areas provided by the employer which otherwise meet the requirements of this section.

(ii) *Decontamination area entry procedures.* The employer shall ensure that employees:

(A) Enter the decontamination area through the clean room;

(B) Remove and deposit street clothing within a locker provided for their use; and

(C) Put on protective clothing and respiratory protection before leaving the clean room.

(D) Before entering the regulated area, the employer shall ensure that employees pass through the equipment room.

(iii) *Decontamination area exit procedures.* The employer shall ensure that:

(A) Before leaving the regulated area, employees shall remove all gross contamination and debris from their protective clothing.

(B) Employees shall remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers.

(C) Employees shall not remove their respirators in the equipment room.

(D) Employees shall shower prior to entering the clean room.

(E) After showering, employees shall enter the clean room before changing into street clothes.

(iv) *Lunch areas.* Whenever food or beverages are consumed at the worksite where employees are performing Class I asbestos work, the employer shall provide lunch areas in which the airborne concentrations of asbestos are below the permissible exposure limit and/or excursion limit.

(2) *Requirements for Class I work involving less than 25 linear or 10 square feet of TSI or surfacing and PACM, and for Class II and Class III asbestos work operations where exposures exceed a PEL or where there is no negative exposure assessment produced before the operation.* (i) The employer shall establish an equipment room or area that is adjacent to the regulated area for the decontamination of employees and their equipment which is contaminated with asbestos which shall consist of an area covered by a impermeable drop cloth on the floor/deck or horizontal working surface.

(ii) The area must be of sufficient size as to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area (as determined by visible accumulations).

(iii) Work clothing must be cleaned with a HEPA vacuum before it is removed.

(iv) All equipment and surfaces of containers filled with ACM must be cleaned prior to removing them from the equipment room or area.

(v) The employer shall ensure that employees enter and exit the regulated area through the equipment room or area.

(3) *Requirements for Class IV work.* Employers shall ensure that employees performing Class IV work within a regulated area comply with the hygiene practice required of employees performing work which has a higher classification within that regulated area. Otherwise employers of employees cleaning up debris and material which is TSI or surfacing ACM or identified as PACM shall provide decontamination facilities for such employees which are required by paragraph (j)(2) of this section.

(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.

(k) *Communication of hazards.* (1) This section applies to the communication of information concerning asbestos hazards in shipyard employment activities to facilitate compliance with this standard. Most asbestos-related shipyard activities involve previously installed building materials. Building/vessel owners often are the only and/or best sources of information concerning them. Therefore, they, along with employers of potentially exposed employees, are assigned specific information conveying and retention duties under this section. Installed Asbestos Containing Building/Vessel Material: Employers and building/vessel owners shall identify TSI and sprayed or troweled on surfacing materials as asbestos-containing unless the employer, by complying with paragraph (k)(5) of this section determines that the material is not asbestos-containing. Asphalt or vinyl flooring/decking material installed in buildings or vessels no later than 1980 must also be considered as asbestos containing unless the employer/owner, pursuant to paragraph (g)(8)(i)(I) of this section, determines it is not asbestos containing. If the employer or building/vessel owner has actual knowledge or should have known, through the exercise of due diligence, that materials other than TSI and sprayed-on or troweled-on surfacing materials are asbestos-containing, they must be treated as such. When communicating information to employees pursuant to this standard, owners and employers shall identify ''PACM'' as ACM. Additional requirements relating to communication of asbestos work on multi- employer worksites are set out in paragraph (d) of this standard.

(2) *Duties of building/vessel and facility owners.* (i) Before work subject to this standard is begun, building/vessel and

facility owners shall determine the presence, location, and quantity of ACM and/or PACM at the work site pursuant to paragraph (k)(1) of this section.

(ii) Building/vessel and/or facility owners shall notify the following persons of the presence, location and quantity of ACM or PACM, at work sites in their buildings/facilities/vessels. Notification either shall be in writing or shall consist of a personal communication between the owner and the person to whom notification must be given or their authorized representatives:

(A) Prospective employers applying or bidding for work whose employees reasonably can be expected to work in or adjacent to areas containing such material;

(B) Employees of the owner who will work in or adjacent to areas containing such material:

(C) On multi-employer worksites, all employers of employees who will be performing work within or adjacent to areas containing such materials;

(D) Tenants who will occupy areas containing such materials.

(3) Duties of employers whose employees perform work subject to this standard in or adjacent to areas containing ACM and PACM. Building/vessel and facility owners whose employees perform such work shall comply with these provisions to the extent applicable.

(i) Before work in areas containing ACM and PACM is begun, employers shall identify the presence, location, and quantity of ACM, and/or PACM therein pursuant to paragraph (k)(1) of this section.

(ii) Before work under this standard is performed employers of employees who will perform such work shall inform the following persons of the location and quantity of ACM and/or PACM present at the work site and the precautions to be taken to insure that airborne asbestos is confined to the area.

(A) Owners of the building/vessel or facility;

(B) Employees who will perform such work and employers of employees who work and/or will be working in adjacent areas;

(iii) Within 10 days of the completion of such work, the employer whose employees have performed work subject to this standard, shall inform the building/vessel or facility owner and employers of employees who will be working in the area of the current location and quantity of PACM and/or ACM remaining in the former regulated area and final monitoring results, if any.

(4) In addition to the above requirements, all employers who discover ACM and/or PACM on a work site shall convey information concerning the presence, location and quantity of such newly discovered ACM and/or PACM to the owner and to other employers of employees working at the work site, within 24 hours of the discovery.

(5) Criteria to rebut the designation of installed material as PACM. (i) At any time, an employer and/or building/vessel owner may demonstrate, for purposes of this standard, that PACM does not contain asbestos. Building/vessel owners and/or employers are not required to communicate information about the presence of building material for which such a demonstration pursuant to the requirements of paragraph (k)(5)(ii) of this section has been made. However, in all such cases, the information, data and analysis supporting the determination that PACM does not contain asbestos, shall be retained pursuant to paragraph (n) of this section.

(ii) An employer or owner may demonstrate that PACM does not contain more than 1% asbestos by the following:

(A) Having a completed inspection conducted pursuant to the requirements of AHERA (40 CFR part 763, subpart E) which demonstrates that the material is not ACM; or

(B) Performing tests of the material containing PACM which demonstrate that no ACM is present in the material. Such tests shall include analysis of bulk samples collected in the manner described in 40 CFR 763.86. The tests, evaluation and sample collection shall be conducted by an accredited inspector or by a CIH. Analysis of samples

shall be performed by persons or laboratories with proficiency demonstrated by current successful participation in a nationally recognized testing program such as the National Voluntary Laboratory Accreditation Program (NVLAP) or the National Institute for Standards and Technology (NIST) or the Round Robin for bulk samples administered by the American Industrial Hygiene Association (AIHA), or an equivalent nationally-recognized round robin testing program..

(iii) The employer and/or building/vessel owner may demonstrate that flooring material including associated mastic and backing does not contain asbestos, by a determination of an industrial hygienist based upon recognized analytical techniques showing that the material is not ACM.

(6) At the entrance to mechanical rooms/areas in which employees reasonably can be expected to enter and which contain ACM and/or PACM, the building/vessel owner shall post signs which identify the material which is present, its location, and appropriate work practices which, if followed, will ensure that ACM and/or PACM will not be disturbed. The employer shall ensure, to the extent feasible, that employees who come in contact with these signs can comprehend them. Means to ensure employee comprehension may include the use of foreign languages, pictographs, graphics, and awareness training.

(7) *Signs.* (i) Warning signs that demarcate the regulated area shall be provided and displayed at each location where a regulated area is required to be established by paragraph (e) of this section. Signs shall be posted at such a distance from such a location that an employee may read the signs and take necessary protective steps before entering the area marked by the signs.

(ii)(A) The warning signs required by paragraph (k)(7) of this section shall bear the following information:

DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY

(B) In addition, where the use of respirators and protective clothing is required in the regulated area under this section, the warning signs shall include the following:

RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

(iii) The employer shall ensure that employees working in and contiguous to regulated areas comprehend the warning signs required to be posted by paragraph (k)(7)(i) of this section. Means to ensure employee comprehension may include the use of foreign languages, pictographs and graphics.

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

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

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

DANGER

CONTAINS ASBESTOS FIBERS

AVOID CREATING DUST

CANCER AND LUNG DISEASE HAZARD

(iv) [Reserved]

(v) Labels shall contain a warning statement against breathing asbestos fibers.

(vi) The provisions for labels required by paragraphs (k)(8) (i) through (k)(8) (iii) of this section do not apply where:

(A) 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 asbestos fibers in excess of the permissible exposure limit and/or excursion limit will be released, or

(B) Asbestos is present in a product in concentrations less than 1.0 percent.

(vii) When a building/vessel owner or employer identifies previously installed PACM and/or ACM, labels or signs shall be affixed or posted so that employees will be notified of what materials contain PACM and/or ACM. The employer shall attach such labels in areas where they will clearly be noticed by employees who are likely to be exposed, such as at the entrance to mechanical room/areas. Signs required by paragraph (k)(6) of this section may be posted in lieu of labels so long as they contain information required for labelling. The employer shall ensure, to the extent feasible, that employees who come in contact with these signs or labels can comprehend them. Means to ensure employee comprehension may include the use of foreign languages, pictographs, graphics, and awareness training.

(9) *Employee information and training.* (i) The employer shall, at no cost to the employee, institute a training program for all employees who are likely to be exposed in excess of a PEL and for all employees who perform Class I through IV asbestos operations, and shall 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) Training for Class I operations and for Class II operations that require the use of critical barriers (or equivalent isolation methods) and/or negative pressure enclosures under this section shall be the equivalent in curriculum, training method and length to the EPA Model Accreditation Plan (MAP) asbestos abatement workers training (40 CFR part 763, subpart E, appendix C).

(iv) Training for other Class II work.

(A) For work with asbestos containing roofing materials, flooring materials, siding materials, ceiling tiles, or transite panels, training shall include at a minimum all the elements included in paragraph (k)(9)(viii) of this section and in addition, the specific work practices and engineering controls set forth in paragraph (g) of this section which specifically relate to that category. Such course shall include ''hands-on'' training and shall take at least 8 hours.

(B) An employee who works with more than one of the categories of material specified in paragraph (k)(9)(iv)(A) of this section shall receive training in the work practices applicable to each category of material that the employee removes and each removal method that the employee uses.

(C) For Class II operations not involving the categories of material specified in paragraph (k)(9)(iv)(A) of this section, training shall be provided which shall include at a minimum all the elements included in paragraph (k)(9)(viii) of this section and in addition, the specific work practices and engineering controls set forth in paragraph (g) of this section which specifically relate to the category of material being removed, and shall include ''hands-on'' training in the work practices applicable to each category of material that the employee removes and each removal method that the employee uses.

(v) Training for Class III employees shall be consistent with EPA requirements for training of local education agency maintenance and custodial staff as set forth at 40 CFR 763.92(a)(2). Such a course shall also include ''hands-on'' training and shall take at least 16 hours. Exception: For Class III operations for which the competent person determines that the EPA curriculum does not adequately cover the training needed to perform that activity, training shall include as a minimum all the elements included in paragraph (k)(9)(viii) of this section and in addition, the specific work practices and engineering controls set forth in paragraph (g) of this section which specifically relate to that activity, and shall include ''hands-on'' training in the

work practices applicable to each category of material that the employee disturbs.

(vi) Training for employees performing Class IV operations shall be consistent with EPA requirements for training of local education agency maintenance and custodial staff as set forth at 40 CFR 763.92(a)(1). Such a course shall include available information concerning the locations of thermal system insulation and surfacing ACM/PACM, and asbestos-containing flooring material, or flooring material where the absence of asbestos has not yet been certified; and instruction in recognition of damage, deterioration, and delamination of asbestos containing building materials. Such course shall take at least 2 hours.

(vii) Training for employees who are likely to be exposed in excess of the PEL and who are not otherwise required to be trained under paragraph (k)(9) (iii) through (vi) of this section, shall meet the requirements of paragraph (k)(9)(viii) of this section.

(viii) The training program shall be conducted in a manner that the employee is able to understand. In addition to the content required by provisions in paragraphs (k)(9) (iii) through (vi) of this section, the employer shall ensure that each such employee is informed of the following:

(A) Methods of recognizing asbestos, including the requirement in paragraph (k)(1) of this section to presume that certain building materials contain asbestos;

(B) The health effects associated with asbestos exposure;

(C) The relationship between smoking and asbestos in producing lung cancer;

(D) The nature of operations that could result in exposure to asbestos, the importance of necessary protective controls to minimize exposure including, as applicable, engineering controls, work practices, respirators, housekeeping procedures, hygiene facilities, protective clothing, decontamination procedures, emergency procedures, and waste disposal procedures, and any necessary instruction in the use of these controls and procedures; where Class III and IV work will be or is performed, the contents of EPA 20T–2003, ''Managing Asbestos In-Place'' July 1990 or its equivalent in content;

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

(F) The appropriate work practices for performing the asbestos job;

(G) Medical surveillance program requirements;

(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 J to this section, to comply with this requirement; and

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

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

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

(iii) 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 J to this section.

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

(2) *Waste disposal*. Asbestos waste, scrap, debris, bags, containers, equipment, and contaminated clothing consigned for disposal shall be collected

and disposed of in sealed, labeled, impermeable bags or other closed, labeled, impermeable containers except in roofing operations, where the procedures specified in paragraph (g)(8)(ii) of this section apply.

(3) *Care of asbestos-containing flooring/deck material.* (i) All vinyl and asphalt flooring/deck material shall be maintained in accordance with this paragraph unless the building/facility owner demonstrates, pursuant to paragraph (g)(8)(i)(I) of this section that the flooring/deck does not contain asbestos.

(ii) Sanding of flooring/deck material is prohibited.

(iii) Stripping of finishes shall be conducted using low abrasion pads at speeds lower than 300 rpm and wet methods.

(iv) Burnishing or dry buffing may be performed only on flooring/deck which has sufficient finish so that the pad cannot contact the flooring/deck material.

(4) Waste and debris and accompanying dust in an area containing accessible thermal system insulation or surfacing ACM/PACM or visibly deteriorated ACM:

(i) Shall not be dusted or swept dry, or vacuumed without using a HEPA filter;

(ii) Shall be promptly cleaned up and disposed of in leak tight containers.

(m) *Medical surveillance*—(1) *General*—(i) *Employees covered.* (A) The employer shall institute a medical surveillance program for all employees who for a combined total of 30 or more days per year are engaged in Class I, II and III work or are exposed at or above a permissible exposure limit. For purposes of this paragraph, any day in which a worker engages in Class II or Class III operations or a combination thereof on intact material for one hour or less (taking into account the entire time spent on the removal operation, including cleanup) and, while doing so, adheres fully to the work practices specified in this standard, shall not be counted.

(B) For employees otherwise required by this standard to wear a negative pressure respirator, employers shall ensure employees are physically able to perform the work and use the equipment. This determination shall be made under the supervision of a physician.

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

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

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

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

(B) When the employee is assigned to an area where exposure to asbestos may be at or above the permissible exposure limit for 30 or more days per year, or engage in Class I, II, or III work for a combined total of 30 or more days per year, a medical examination must be given within 10 working days following the thirtieth day of exposure;

(C) And at least annually thereafter.

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

(E) Exception: No medical examination is required of any employee if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(ii) *Content.* Medical examinations made available pursuant to paragraphs (m)(2)(i) (A) through (m)(2)(i) (C) of this section shall include:

(A) A medical and work history with special emphasis directed to the pulmonary, cardiovascular, and gastrointestinal systems.

(B) On initial examination, the standardized questionnaire contained in part 1 of appendix D to this section and, on annual examination, the abbreviated standardized questionnaire contained in part 2 of appendix D to this section.

(C) A physical examination directed to the pulmonary and gastrointestinal systems, including a chest x-ray to be administered at the discretion of the physician, and pulmonary function tests of forced vital capacity (FVC) and forced expiratory volume at one second (FEV(1)). Interpretation and classification of chest roentgenogram shall be conducted in accordance with appendix E to this section.

(D) Any other examinations or tests deemed necessary by the examining physician.

(3) *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, E, and I to this section;

(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;

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

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

(4) *Physician's written opinion.* (i) The employer shall obtain a written 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 on the use of personal protective equipment such as 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 that may result from asbestos exposure.

(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.

(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.

(n) *Recordkeeping*—(1) *Objective data relied on pursuant to paragraph (f) of this section.* (i) Where the employer has relied on objective data that demonstrates that products made from or containing asbestos or the activity involving such products or material are not capable of releasing fibers of asbestos in concentrations at or above the permissible exposure limit and/or excursion limit under the expected conditions of processing, use, or handling to satisfy the requirements of paragraph (f) 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 information:

(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.

(2) *Exposure measurements.* (i) The employer shall keep an accurate record of all measurements taken to monitor employee exposure to asbestos as prescribed in paragraph (f) of this section. Note: The employer may utilize the services of qualified organizations such

as industry trade associations and employee associations to maintain the records required by this section.

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

(A) The date of measurement;

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

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

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

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

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

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

(3) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance by paragraph (m) 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) A copy of the employee's medical examination results, including the medical history, questionnaire responses, results of any tests, and physician's recommendations.

(C) Physician's written opinions;

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

(E) A copy of the information provided to the physician as required by paragraph (m) 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 records.* The employer shall maintain all employee training records for one (1) year beyond the last date of employment by that employer.

(5) *Data to rebut PACM.* (i) Where the building owner and employer have relied on data to demonstrate that PACM is not asbestos-containing, such data shall be maintained for as long as they are relied upon to rebut the presumption.

(ii) [Reserved]

(6) *Records of required notification.* (i) Where the building/vessel owner has communicated and received information concerning the identity, location and quantity of ACM and PACM, written records of such notifications and their content shall be maintained by the owner for the duration of ownership and shall be transferred to successive owners of such buildings/facilities/vessels.

(ii) [Reserved]

(7) *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 paragraphs (f) and (n) 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) through (e) and (g) through (i).

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

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

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

(o) *Qualified person*—(1) *General.* On all shipyard worksites covered by this standard, the employer shall designate a qualified person, having the qualifications and authorities for ensuring worker safety and health required by subpart C, General Safety and Health Provisions for Construction (29 CFR 1926.20 through 1926.32).

(2) *Required inspections by the qualified person.* §1926.20(b)(2) which requires health and safety prevention programs to provide for frequent and regular inspections of the job sites, materials, and equipment to be made by qualified persons, is incorporated.

(3) *Additional inspections.* In addition, the qualified person shall make frequent and regular inspections of the job sites, in order to perform the duties set out in paragraph (o)(3)(i) of this section. For Class I jobs, on-site inspections shall be made at least once during each work shift, and at any time at employee request. For Class II, III and IV jobs, on-site inspections shall be made at intervals sufficient to assess whether conditions have changed, and at any reasonable time at employee request.

(i) On all worksites where employees are engaged in Class I or II asbestos work, the qualified person designated in accordance with paragraph (e)(6) of this section shall perform or supervise the following duties, as applicable:

(A) Set up the regulated area, enclosure, or other containment;

(B) Ensure (by on-site inspection) the integrity of the enclosure or containment;

(C) Set up procedures to control entry to and exit from the enclosure and/or area;

(D) Supervise all employee exposure monitoring required by this section and ensure that it is conducted as required by paragraph (f) of this section;

(E) Ensure that employees working within the enclosure and/or using glove bags wear respirators and protective clothing as required by paragraphs (h) and (i) of this section;

(F) Ensure through on-site supervision, that employees set up, use, and remove engineering controls, use work practices and personal protective equipment in compliance with all requirements;

(G) Ensure that employees use the hygiene facilities and observe the decontamination procedures specified in paragraph (j) of this section;

(H) Ensure that through on-site inspection, engineering controls are functioning properly and employees are using proper work practices; and

(I) Ensure that notification requirements in paragraph (k) of this section are met.

(4) *Training for the competent person.* (i) For Class I and II asbestos work the qualified person shall be trained in all aspects of asbestos removal and handling, including: Abatement, installation, removal and handling; the contents of this standard; the identification of asbestos; removal procedures, where appropriate; and other practices for reducing the hazard. Such training shall be obtained in a comprehensive course for supervisors, that meets the criteria of EPA's Model Accreditation Plan (40 CFR part 763, subpart E, appendix C), such as a course conducted by an EPA-approved or state-approved training provider, certified by EPA or a state, or a course equivalent in stringency, content, and length.

(ii) For Class III and IV asbestos work, the qualified person shall be trained in aspects of asbestos handling appropriate for the nature of the work, to include procedures for setting up glove bags and mini-enclosures, practices for reducing asbestos exposures, use of wet methods, the contents of this standard, and the identification of asbestos. Such training shall include successful completion of a course that is consistent with EPA requirements for training of local education agency maintenance and custodial staff as set forth at 40 CFR 763.92(a)(2), or its equivalent in stringency, content, and length. Qualified persons for Class III and Class IV work may also be trained pursuant to the requirements of paragraph (o)(4)(i) of this section.

(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, H, I, J, and K to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

(q) *Dates.* (1) This standard shall become effective October 11, 1994.

(2) The provisions of 29 CFR 1926.58 and 29 CFR 1910.1001 remain in effect until the start-up dates of the equivalent provisions of this standard.

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

(i) *Methods of compliance.* The engineering and work practice controls required by paragraph (g) of this section shall be implemented by October 1, 1995.

(ii) *Respiratory protection.* Respiratory protection required by paragraph (h) of this section shall be provided by October 1, 1995.

(iii) *Hygiene facilities and practices for employees.* Hygiene facilities and practices required by paragraph (j) of this section shall be provided by October 1, 1995.

(iv) *Communication of hazards.* Identification, notification, labeling and sign posting, and training required by paragraph (k) of this section shall be provided by October 1, 1995.

(v) *Housekeeping.* Housekeeping practices and controls required by paragraph (l) of this section shall be provided by October 1, 1995.

(vi) Medical surveillance required by paragraph (m) of this section shall be provided by October 1, 1995.

(vii) The designation and training of qualified persons required by paragraph (o) of this section shall be completed by October 1, 1995.

APPENDIX A TO § 1915.1001—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 appendix B to this section, the most current version of the OSHA method ID–160, or the most current version of the NIOSH Method 7400) which OSHA considers to be essential to achieve adequate employee exposure monitoring while allowing employers to use methods that are already established within their organizations. All employers who are required to conduct air monitoring under paragraph (f) of this section 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 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. Other cassettes such as the Bell-mouth may be used within the limits of their validation. Do not reuse or reload cassettes for asbestos sample collection.

3. An air flow rate between 0.5 liter/min and 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 5 liters/min shall be selected.

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

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

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

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

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

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

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

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

b. Bring the blocks of grooved lines into focus.

NOTE: The slide consists of seven sets of grooved lines (ca. 20 grooves to each block) in descending order of visibility from sets 1 to 7, seven being the least visible. The requirements for asbestos, tremolite, anthophyllite, and actinolite counting are

that the microscope optics must resolve the grooved lines in set 3 completely, although they may appear somewhat faint, and that the grooved lines in sets 6 and 7 must be invisible. Sets 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope that fails to meet these requirements has either too low or too high a resolution to be used for asbestos, tremolite, anthophyllite, and actinolite counting.

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

11. Each set of samples taken will include 10% field blanks or a minimum of 2 field blanks. These blanks must come from the same lot as the filters used for sample collection. The field blank results shall be averaged and subtracted from the analytical results before reporting. A set consists of any sample or group of samples for which an evaluation for this standard must be made. Any samples represented by a field blank having a fiber count in excess of the detection limit of the method being used 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 to 1 or greater.

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

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

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

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

Quality Control Procedures

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

b. All laboratories should participate in a national sample testing scheme such as the Proficiency Analytical Testing Program (PAT), the Asbestos Registry sponsored by the American Industrial Hygiene Association (AIHA).

3. All individuals performing asbestos, tremolite, anthophyllite, and actinolite analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos, tremolite, anthophyllite, and actinolite 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.

APPENDIX B TO § 1915.1001—DETAILED PROCEDURES FOR ASBESTOS SAMPLING AND ANALYSIS (NON-MANDATORY)

Matrix:	Air
OSHA Permissible Exposure Limits:	
Time Weighted Average	0.1 fiber/cc
Excursion Level (30 minutes)	1.0 fiber/cc
Collection Procedure:	

A known volume of air is drawn through a 25-mm diameter cassette containing a mixed-cellulose ester filter. The cassette must be equipped with an electrically conductive 50-mm extension cowl. The sampling time and rate are chosen to give a fiber density of between 100 to 1,300 fibers/mm^2 on the filter.	
Recommended Sampling Rate	0.5 to 5.0 liters/minute (L/min)
Recommended Air Volumes:	
Minimum	25 L
Maximum	2,400 L

Analytical Procedure: A portion of the sample filter is cleared and prepared for asbestos fiber counting by Phase Contrast Microscopy (PCM) at 400X.

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL-OSHA. Similar products from other sources can be substituted.

1. INTRODUCTION

This method describes the collection of airborne asbestos fibers using calibrated sampling pumps with mixed-cellulose ester (MCE) filters and analysis by phase contrast microscopy (PCM). Some terms used are unique to this method and are defined below:

Asbestos: A term for naturally occurring fibrous minerals. Asbestos includes chrysotile, crocidolite, amosite (cummingtonite-grunerite asbestos), tremolite asbestos, actinolite asbestos, anthophyllite asbestos, and any of these minerals that have been chemically treated and/or altered. The precise chemical formulation of each species will vary with the location from which it was mined. Nominal compositions are listed:

Chrysotile	$Mg_3Si_2O_5(OH)_4$
Crocidolite.	$Na_2Fe_32+Fe_23+Si_8O_{22}(OH)2$
Amosite ..	$(Mg,Fe)_7Si_8O_{22}(OH)_2$
Tremolite-actinolite.	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
Anthophyllite.	$(Mg,Fe)_7Si_8O_{22}(OH)_2$

Asbestos Fiber: A fiber of asbestos which meets the criteria specified below for a fiber.

Aspect Ratio: The ratio of the length of a fiber to it's diameter (e.g. 3:1, 5:1 aspect ratios).

Cleavage Fragments: Mineral particles formed by comminution of minerals, especially those characterized by parallel sides and a moderate aspect ratio (usually less than 20:1).

Detection Limit: The number of fibers necessary to be 95% certain that the result is greater than zero.

Differential Counting: The term applied to the practice of excluding certain kinds of fibers from the fiber count because they do not appear to be asbestos.

Fiber: A particle that is 5 μ m or longer, with a length-to-width ratio of 3 to 1 or longer.

Field: The area within the graticule circle that is superimposed on the microscope image.

Set: The samples which are taken, submitted to the laboratory, analyzed, and for which, interim or final result reports are generated.

Tremolite, Anthophyllite, and Actinolite: The non-asbestos form of these minerals which meet the definition of a fiber. It includes any of these minerals that have been chemically treated and/or altered.

Walton-Beckett Graticule: An eyepiece graticule specifically designed for asbestos fiber counting. It consists of a circle with a projected diameter of 100 ± 2 μ m (area of about 0.00785 mm^2) with a crosshair having ticmarks at 3-μ m intervals in one direction and 5-μ m in the orthogonal direction. There are marks around the periphery of the circle to demonstrate the proper sizes and shapes of fibers. This design is reproduced in figure 1. The disk is placed in one of the microscope eyepieces so that the design is superimposed on the field of view.

1.1. History

Early surveys to determine asbestos exposures were conducted using impinger counts of total dust with the counts expressed as million particles per cubic foot. The British Asbestos Research Council recommended filter membrane counting in 1969. In July 1969, the Bureau of Occupational Safety and Health published a filter membrane method for counting asbestos fibers in the United States. This method was refined by NIOSH and published as P & CAM 239. On May 29, 1971, OSHA specified filter membrane sampling with phase contrast counting for evaluation of asbestos exposures at work sites in the United States. The use of this technique was again required by OSHA in 1986. Phase contrast microscopy has continued to be the method of choice for the measurement of occupational exposure to asbestos.

1.2. Principle

Air is drawn through a MCE filter to capture airborne asbestos fibers. A wedge shaped portion of the filter is removed, placed on a glass microscope slide and made transparent.

A measured area (field) is viewed by PCM. All the fibers meeting defined criteria for asbestos are counted and considered a measure of the airborne asbestos concentration.

1.3. Advantages and Disadvantages

There are four main advantages of PCM over other methods:

(1) The technique is specific for fibers. Phase contrast is a fiber counting technique which excludes non-fibrous particles from the analysis.

(2) The technique is inexpensive and does not require specialized knowledge to carry out the analysis for total fiber counts.

(3) The analysis is quick and can be performed on-site for rapid determination of air concentrations of asbestos fibers.

(4) The technique has continuity with historical epidemiological studies so that estimates of expected disease can be inferred from long-term determinations of asbestos exposures.

The main disadvantage of PCM is that it does not positively identify asbestos fibers. Other fibers which are not asbestos may be included in the count unless differential counting is performed. This requires a great deal of experience to adequately differentiate asbestos from non-asbestos fibers. Positive identification of asbestos must be performed by polarized light or electron microscopy techniques. A further disadvantage of PCM is that the smallest visible fibers are about 0.2 μ m in diameter while the finest asbestos fibers may be as small as 0.02 μ m in diameter. For some exposures, substantially more fibers may be present than are actually counted.

1.4. Workplace Exposure

Asbestos is used by the construction industry in such products as shingles, floor tiles, asbestos cement, roofing felts, insulation and acoustical products. Non-construction uses include brakes, clutch facings, paper, paints, plastics, and fabrics. One of the most significant exposures in the workplace is the removal and encapsulation of asbestos in schools, public buildings, and homes. Many workers have the potential to be exposed to asbestos during these operations.

About 95% of the asbestos in commercial use in the United States is chrysotile. Crocidolite and amosite make up most of the remainder. Anthophyllite and tremolite or actinolite are likely to be encountered as contaminants in various industrial products.

1.5. Physical Properties

Asbestos fiber possesses a high tensile strength along its axis, is chemically inert, non-combustible, and heat resistant. It has a high electrical resistance and good sound absorbing properties. It can be weaved into cables, fabrics or other textiles, and also matted into asbestos papers, felts, or mats.

2. Range and Detection Limit

2.1. The ideal counting range on the filter is 100 to 1,300 fibers/mm^2. With a Walton-Beckett graticule this range is equivalent to 0.8 to 10 fibers/field. Using NIOSH counting statistics, a count of 0.8 fibers/field would give an approximate coefficient of variation (CV) of 0.13.

2.2. The detection limit for this method is 4.0 fibers per 100 fields or 5.5 fibers/mm^2. This was determined using an equation to estimate the maximum CV possible at a specific concentration (95% confidence) and a Lower Control Limit of zero. The CV value was then used to determine a corresponding concentration from historical CV vs fiber relationships. As an example:

Lower Control Limit (95% Confidence) = AC—1.645(CV)(AC)

Where:

AC = Estimate of the airborne fiber concentration (fibers/cc) Setting the Lower Control Limit = 0 and solving for CV:

0 = AC—1.645(CV)(AC)

CV = 0.61

This value was compared with CV vs. count curves. The count at which CV = 0.61 for Leidel-Busch counting statistics (8.9.) or for an OSHA Salt Lake Technical Center (OSHA-SLTC) CV curve (see appendix A for further information) was 4.4 fibers or 3.9 fibers per 100 fields, respectively. Although a lower detection limit of 4 fibers per 100 fields is supported by the OSHA-SLTC data, both data sets support the 4.5 fibers per 100 fields value.

3. Method Performance—Precision and Accuracy

Precision is dependent upon the total number of fibers counted and the uniformity of the fiber distribution on the filter. A general rule is to count at least 20 and not more than 100 fields. The count is discontinued when 100 fibers are counted, provided that 20 fields have already been counted. Counting more than 100 fibers results in only a small gain in precision. As the total count drops below 10 fibers, an accelerated loss of precision is noted.

At this time, there is no known method to determine the absolute accuracy of the asbestos analysis. Results of samples prepared through the Proficiency Analytical Testing (PAT) Program and analyzed by the OSHA-SLTC showed no significant bias when compared to PAT reference values. The PAT samples were analyzed from 1987 to 1989 (N=36) and the concentration range was from 120 to 1,300 fibers/mm^2.

4. Interferences

Fibrous substances, if present, may interfere with asbestos analysis.

Some common fibers are:

fiberglass
anhydrate
plant fibers
perlite veins
gypsum
some synthetic fibers
membrane structures
sponge spicules
diatoms
microorganism
wollastonite

The use of electron microscopy or optical tests such as polarized light, and dispersion staining may be used to differentiate these materials from asbestos when necessary.

5. Sampling

5.1. Equipment

5.1.1. Sample assembly (The assembly is shown in figure 3). Conductive filter holder consisting of a 25-mm diameter, 3-piece cassette having a 50-mm long electrically conductive extension cowl. Backup pad, 25-mm, cellulose. Membrane filter, mixed-cellulose ester (MCE), 25-mm, plain, white, 0.4 to 1.2-μm pore size.

NOTES: (a) DO NOT RE-USE CASSETTES.

(b) Fully conductive cassettes are required to reduce fiber loss to the sides of the cassette due to electrostatic attraction.

(c) Purchase filters which have been selected by the manufacturer for asbestos counting or analyze representative filters for fiber background before use. Discard the filter lot if more than 4 fibers/100 fields are found.

(d) To decrease the possibility of contamination, the sampling system (filter-backup pad-cassette) for asbestos is usually preassembled by the manufacturer.

(e) Other cassettes, such as the Bell-mouth, may be used within the limits of their validation.

5.1.2. Gel bands for sealing cassettes.

5.1.3. Sampling pump.

Each pump must be a battery operated, self-contained unit small enough to be placed on the monitored employee and not interfere with the work being performed. The pump must be capable of sampling at the collection rate for the required sampling time.

5.1.4. Flexible tubing, 6-mm bore.

5.1.5. Pump calibration.

Stopwatch and bubble tube/burette or electronic meter.

5.2. Sampling Procedure

5.2.1. Seal the point where the base and cowl of each cassette meet with a gel band or tape.

5.2.2. Charge the pumps completely before beginning.

5.2.3. Connect each pump to a calibration cassette with an appropriate length of 6-mm bore plastic tubing. Do not use luer connectors—the type of cassette specified above has built-in adapters.

5.2.4. Select an appropriate flow rate for the situation being monitored. The sampling flow rate must be between 0.5 and 5.0 L/min for personal sampling and is commonly set between 1 and 2 L/min. Always choose a flow rate that will not produce overloaded filters.

5.2.5. Calibrate each sampling pump before and after sampling with a calibration cassette in-line (Note: This calibration cassette should be from the same lot of cassettes used for sampling). Use a primary standard (e.g. bubble burette) to calibrate each pump. If possible, calibrate at the sampling site.

NOTE: If sampling site calibration is not possible, environmental influences may affect the flow rate. The extent is dependent on the type of pump used. Consult with the pump manufacturer to determine dependence on environmental influences. If the pump is affected by temperature and pressure changes, correct the flow rate by using the formula shown in the section ''Sampling Pump Flow Rate Corrections'' at the end of this appendix.

5.2.6. Connect each pump to the base of each sampling cassette with flexible tubing. Remove the end cap of each cassette and take each air sample open face. Assure that each sample cassette is held open side down in the employee's breathing zone during sampling. The distance from the nose/mouth of the employee to the cassette should be about 10 cm. Secure the cassette on the collar or lapel of the employee using spring clips or other similar devices.

5.2.7. A suggested minimum air volume when sampling to determine TWA compliance is 25 L. For Excursion Limit (30 min sampling time) evaluations, a minimum air volume of 48 L is recommended.

5.2.8. The most significant problem when sampling for asbestos is overloading the filter with non-asbestos dust. Suggested maximum air sample volumes for specific environments are:

Environment	Air vol. (L)
Asbestos removal operations (visible dust)	100
Asbestos removal operations (little dust)	240
Office environments	400 to 2,400

Caution: Do not overload the filter with dust. High levels of non-fibrous dust particles may obscure fibers on the filter and lower the count or make counting impossible. If more than about 25 to 30% of the field area is obscured with dust, the result may be biased low. Smaller air volumes may

be necessary when there is excessive non-asbestos dust in the air.

While sampling, observe the filter with a small flashlight. If there is a visible layer of dust on the filter, stop sampling, remove and seal the cassette, and replace with a new sampling assembly. The total dust loading should not exceed 1 mg.

5.2.9. Blank samples are used to determine if any contamination has occurred during sample handling. Prepare two blanks for the first 1 to 20 samples. For sets containing greater than 20 samples, prepare blanks as 10% of the samples. Handle blank samples in the same manner as air samples with one exception: Do not draw any air through the blank samples. Open the blank cassette in the place where the sample cassettes are mounted on the employee. Hold it open for about 30 seconds. Close and seal the cassette appropriately. Store blanks for shipment with the sample cassettes.

5.2.10. Immediately after sampling, close and seal each cassette with the base and plastic plugs. Do not touch or puncture the filter membrane as this will invalidate the analysis.

5.2.11 Attach and secure a sample seal around each sample cassette in such a way as to assure that the end cap and base plugs cannot be removed without destroying the seal. Tape the ends of the seal together since the seal is not long enough to be wrapped end-to-end. Also wrap tape around the cassette at each joint to keep the seal secure.

5.3. Sample Shipment

5.3.1. Send the samples to the laboratory with paperwork requesting asbestos analysis. List any known fibrous interferences present during sampling on the paperwork. Also, note the workplace operation(s) sampled.

5.3.2. Secure and handle the samples in such that they will not rattle during shipment nor be exposed to static electricity. Do not ship samples in expanded polystyrene peanuts, vermiculite, paper shreds, or excelsior. Tape sample cassettes to sheet bubbles and place in a container that will cushion the samples in such a manner that they will not rattle.

5.3.3. To avoid the possibility of sample contamination, always ship bulk samples in separate mailing containers.

6. Analysis

6.1. Safety Precautions

6.1.1. Acetone is extremely flammable and precautions must be taken not to ignite it. Avoid using large containers or quantities of acetone. Transfer the solvent in a ventilated laboratory hood. Do not use acetone near any open flame. For generation of acetone vapor, use a spark free heat source.

6.1.2. Any asbestos spills should be cleaned up immediately to prevent dispersal of fibers. Prudence should be exercised to avoid contamination of laboratory facilities or exposure of personnel to asbestos. Asbestos spills should be cleaned up with wet methods and/or a High Efficiency Particulate-Air (HEPA) filtered vacuum.

Caution: Do not use a vacuum without a HEPA filter—It will disperse fine asbestos fibers in the air.

6.2. Equipment

6.2.1. Phase contrast microscope with binocular or trinocular head.

6.2.2. Widefield or Huygenian 10X eyepieces (NOTE: The eyepiece containing the graticule must be a focusing eyepiece. Use a 40X phase objective with a numerical aperture of 0.65 to 0.75).

6.2.3. Kohler illumination (if possible) with green or blue filter.

6.2.4. Walton-Beckett Graticule, type G–22 with 100 ± 2 μm projected diameter.

6.2.5. Mechanical stage. A rotating mechanical stage is convenient for use with polarized light.

6.2.6. Phase telescope.

6.2.7. Stage micrometer with 0.01-mm subdivisions.

6.2.8. Phase-shift test slide, mark II (Available from PTR optics Ltd., and also McCrone).

6.2.9. Precleaned glass slides, 25 mm X 75 mm. One end can be frosted for convenience in writing sample numbers, etc., or paste-on labels can be used.

6.2.10. Cover glass #1½.

6.2.11. Scalpel (#10, curved blade).

6.2.12. Fine tipped forceps.

6.2.13. Aluminum block for clearing filter (see appendix D and figure 4).

6.2.14. Automatic adjustable pipette, 100- to 500-μL.

6.2.15. Micropipette, 5 μL.

6.3. Reagents

6.3.1. Acetone (HPLC grade).

6.3.2. Triacetin (glycerol triacetate).

6.3.3. Lacquer or nail polish.

6.4. Standard Preparation

A way to prepare standard asbestos samples of known concentration has not been developed. It is possible to prepare replicate samples of nearly equal concentration. This has been performed through the PAT program. These asbestos samples are distributed by the AIHA to participating laboratories.

Since only about one-fourth of a 25-mm sample membrane is required for an asbestos count, any PAT sample can serve as a ''standard'' for replicate counting.

6.5. Sample Mounting

NOTE: See Safety Precautions in Section 6.1. before proceeding. The objective is to produce samples with a smooth (non-grainy)

background in a medium with a refractive index of approximately 1.46. The technique below collapses the filter for easier focusing and produces permanent mounts which are useful for quality control and interlaboratory comparison.

An aluminum block or similar device is required for sample preparation.

6.5.1. Heat the aluminum block to about 70 °C. The hot block should not be used on any surface that can be damaged by either the heat or from exposure to acetone.

6.5.2. Ensure that the glass slides and cover glasses are free of dust and fibers.

6.5.3. Remove the top plug to prevent a vacuum when the cassette is opened. Clean the outside of the cassette if necessary. Cut the seal and/or tape on the cassette with a razor blade. Very carefully separate the base from the extension cowl, leaving the filter and backup pad in the base.

6.5.4. With a rocking motion cut a triangular wedge from the filter using the scalpel. This wedge should be one-sixth to one-fourth of the filter. Grasp the filter wedge with the forceps on the perimeter of the filter which was clamped between the cassette pieces. DO NOT TOUCH the filter with your finger. Place the filter on the glass slide sample side up. Static electricity will usually keep the filter on the slide until it is cleared.

6.5.5. Place the tip of the micropipette containing about 200 μ L acetone into the aluminum block. Insert the glass slide into the receiving slot in the aluminum block. Inject the acetone into the block with slow, steady pressure on the plunger while holding the pipette firmly in place. Wait 3 to 5 seconds for the filter to clear, then remove the pipette and slide from the aluminum block.

6.5.6. Immediately (less than 30 seconds) place 2.5 to 3.5 μL of triacetin on the filter (NOTE: Waiting longer than 30 seconds will result in increased index of refraction and decreased contrast between the fibers and the preparation. This may also lead to separation of the cover slip from the slide).

6.5.7. Lower a cover slip gently onto the filter at a slight angle to reduce the possibility of forming air bubbles. If more than 30 seconds have elapsed between acetone exposure and triacetin application, glue the edges of the cover slip to the slide with lacquer or nail polish.

6.5.8. If clearing is slow, warm the slide for 15 min on a hot plate having a surface temperature of about 50 °C to hasten clearing. The top of the hot block can be used if the slide is not heated too long.

6.5.9. Counting may proceed immediately after clearing and mounting are completed.

6.6. Sample Analysis

Completely align the microscope according to the manufacturer's instructions. Then, align the microscope using the following general alignment routine at the beginning of every counting session and more often if necessary.

6.6.1. Alignment

(1) Clean all optical surfaces. Even a small amount of dirt can significantly degrade the image.

(2) Rough focus the objective on a sample.

(3) Close down the field iris so that it is visible in the field of view. Focus the image of the iris with the condenser focus. Center the image of the iris in the field of view.

(4) Install the phase telescope and focus on the phase rings. Critically center the rings. Misalignment of the rings results in astigmatism which will degrade the image.

(5) Place the phase-shift test slide on the microscope stage and focus on the lines. The analyst must see line set 3 and should see at least parts of 4 and 5 but, not see line set 6 or 6. A microscope/microscopist combination which does not pass this test may not be used.

6.6.2. Counting Fibers

(1) Place the prepared sample slide on the mechanical stage of the microscope. Position the center of the wedge under the objective lens and focus upon the sample.

(2) Start counting from one end of the wedge and progress along a radial line to the other end (count in either direction from perimeter to wedge tip). Select fields randomly, without looking into the eyepieces, by slightly advancing the slide in one direction with the mechanical stage control.

(3) Continually scan over a range of focal planes (generally the upper 10 to 15 μm of the filter surface) with the fine focus control during each field count. Spend at least 5 to 15 seconds per field.

(4) Most samples will contain asbestos fibers with fiber diameters less than 1 μm. Look carefully for faint fiber images. The small diameter fibers will be very hard to see. However, they are an important contribution to the total count.

(5) Count only fibers equal to or longer than 5 μm. Measure the length of curved fibers along the curve.

(6) Count fibers which have a length to width ratio of 3:1 or greater.

(7) Count all the fibers in at least 20 fields. Continue counting until either 100 fibers are counted or 100 fields have been viewed; whichever occurs first. Count all the fibers in the final field.

(8) 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 a count of ½. Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may

be visible outside the graticule area. If a fiber touches the circle, it is considered to cross the line.

(9) Count bundles of fibers as one fiber unless individual fibers can be clearly identified and each individual fiber is clearly not connected to another counted fiber. See figure 1 for counting conventions.

(10) Record the number of fibers in each field in a consistent way such that filter non-uniformity can be assessed.

(11) Regularly check phase ring alignment.

(12) When an agglomerate (mass of material) covers more than 25% of the field of view, reject the field and select another. Do not include it in the number of fields counted.

(13) Perform a ''blind recount'' of 1 in every 10 filter wedges (slides). Re-label the slides using a person other than the original counter.

6.7. Fiber Identification

As previously mentioned in Section 1.3., PCM does not provide positive confirmation of asbestos fibers. Alternate differential counting techniques should be used if discrimination is desirable. Differential counting may include primary discrimination based on morphology, polarized light analysis of fibers, or modification of PCM data by Scanning Electron or Transmission Electron Microscopy.

A great deal of experience is required to routinely and correctly perform differential counting. It is discouraged unless it is legally necessary. Then, only if a fiber is obviously not asbestos should it be excluded from the count. Further discussion of this technique can be found in reference 8.10.

If there is a question whether a fiber is asbestos or not, follow the rule:

''WHEN IN DOUBT, COUNT.''

6.8. Analytical Recommendations—Quality Control System

6.8.1. All individuals performing asbestos analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos or an equivalent course.

6.8.2. Each laboratory engaged in asbestos counting shall set up a slide trading arrangement with at least two other laboratories in order to compare performance and eliminate inbreeding of error. The slide exchange occurs at least semiannually. The round robin results shall be posted where all analysts can view individual analyst's results.

6.8.3. Each laboratory engaged in asbestos counting shall participate in the Proficiency Analytical Testing Program, the Asbestos Analyst Registry or equivalent.

6.8.4. Each analyst shall select and count prepared slides from a ''slide bank''. These are quality assurance counts. The slide bank shall be prepared using uniformly distributed samples taken from the workload. Fiber densities should cover the entire range routinely analyzed by the laboratory. These slides are counted blind by all counters to establish an original standard deviation. This historical distribution is compared with the quality assurance counts. A counter must have 95% of all quality control samples counted within three standard deviations of the historical mean. This count is then integrated into a new historical mean and standard deviation for the slide.

The analyses done by the counters to establish the slide bank may be used for an interim quality control program if the data are treated in a proper statistical fashion.

7. Calculations

7.1. Calculate the estimated airborne asbestos fiber concentration on the filter sample using the following formula:

$$AC = \frac{\left[\left(\frac{FB}{FL}\right) - \left(\frac{BFB}{BFL}\right)\right] \times ECA}{1000 \times FR \times T \times MFA}$$

Where:

AC = Airborne fiber concentration

FB = Total number of fibers greater than 5 µm counted

FL = Total number of fields counted on the filter

BFB = Total number of fibers greater than 5 µm counted in the blank

BFL = Total number of fields counted on the blank

ECA = Effective collecting area of filter (385 mm^2 nominal for a 25-mm filter.)

FR = Pump flow rate (L/min)

MFA = Microscope count field area (mm^2). This is 0.00785 mm^2 for a Walton-Beckett Graticule.

T = Sample collection time (min)

1,000 = Conversion of L to cc

NOTE: The collection area of a filter is seldom equal to 385 mm^2. It is appropriate for laboratories to routinely monitor the exact diameter using an inside micrometer. The collection area is calculated according to the formula:

Area = $\pi(d/2)^2$

7.2. Short-cut Calculation

Since a given analyst always has the same interpupillary distance, the number of fields per filter for a particular analyst will remain constant for a given size filter. The field size for that analyst is constant (i.e. the analyst is using an assigned microscope and is not changing the reticle).

For example, if the exposed area of the filter is always 385 mm^2 and the size of the field is always 0.00785 mm^2, the number of fields per filter will always be 49,000. In addition it

is necessary to convert liters of air to cc. These three constants can then be combined such that ECA/(1,000 X MFA) = 49. The previous equation simplifies to:

$$AC = \frac{\left(\frac{FB}{FL}\right) - \left(\frac{BFB}{BFL}\right) \times 49}{FR \times T}$$

7.3. Recount Calculations

As mentioned in step 13 of Section 6.6.2., a ''blind recount'' of 10% of the slides is performed. In all cases, differences will be observed between the first and second counts of the same filter wedge. Most of these differences will be due to chance alone, that is, due to the random variability (precision) of the count method. Statistical recount criteria enables one to decide whether observed differences can be explained due to chance alone or are probably due to systematic differences between analysts, microscopes, or other biasing factors.

The following recount criterion is for a pair of counts that estimate AC in fibers/cc. The criterion is given at the type-I error level. That is, there is 5% maximum risk that we will reject a pair of counts for the reason that one might be biased, when the large observed difference is really due to chance.

Reject a pair of counts if:

$$\left|\sqrt{AC_2} - \sqrt{AC_1}\right| > 2.78 \times \left(\sqrt{AC_{AVG}}\right) \times CV_{FB}$$

Where:

AC_1 = lower estimated airborne fiber concentration

AC_2 = higher estimated airborne fiber concentration

AC_{avg} = average of the two concentration estimates

CV_{FB} = CV for the average of the two concentration estimates

If a pair of counts are rejected by this criterion then, recount the rest of the filters in the submitted set. Apply the test and reject any other pairs failing the test. Rejection shall include a memo to the industrial hygienist stating that the sample failed a statistical test for homogeneity and the true air concentration may be significantly different than the reported value.

7.4. Reporting Results

Report results to the industrial hygienist as fibers/cc. Use two significant figures. If multiple analyses are performed on a sample, an average of the results is to be reported unless any of the results can be rejected for cause.

8. References

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8.6. *Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. Final Rule,* FEDERAL REGISTER 51: 119 (20 June 1986). pp.22612–22790.

8.7. *Asbestos, Tremolite, Anthophyllite, and Actinolite,* Code of Federal Regulations 1910.1001. 1988. pp 711–752.

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8.9. Leidel, N.A., Bayer, S.G., Zumwalde, R.D., Busch, K.A., *USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers* (DHEW/NIOSH Pub. No. 79–127). National Institute for Occupational Safety and Health, Cincinnati, OH, 1979.

8.10. Dixon, W.C., *Applications of Optical Microscopy in Analysis of Asbestos and Quartz,* Analytical Techniques in Occupational Health Chemistry, edited by D.D. Dollberg and A.W. Verstuyft. Wash. D.C.: American Chemical Society, (ACS Symposium Series 120) 1980. pp. 13–41.

Quality Control

The OSHA asbestos regulations require each laboratory to establish a quality control program. The following is presented as an example of how the OSHA–SLTC constructed its internal CV curve as part of meeting this requirement. Data is from 395 samples collected during OSHA compliance inspections and analyzed from October 1980 through April 1986.

Each sample was counted by 2 to 5 different counters independently of one another. The standard deviation and the CV

statistic was calculated for each sample. This data was then plotted on a graph of CV vs. fibers/mm^2. A least squares regression was performed using the following equation:

$CV = \text{antilog}_{10}[A(\log_{10}(x))^2+B(\log_{10}(x))+C]$

Where:

x = the number of fibers/mm^2

Application of least squares gave:

A = 0.182205
B = −0.973343
C = 0.327499

Using these values, the equation becomes:

$CV = \text{antilog}_{10}[0.182205(\log_{10}(x))^2 - 0.973343(\log_{10}(x))+0.327499]$

Sampling Pump Flow Rate Corrections

This correction is used if a difference greater than 5% in ambient temperature and/or pressure is noted between calibration and sampling sites and the pump does not compensate for the differences.

$$Q_{act} = Q_{cal} \times \sqrt{\left(\frac{P_{cal}}{P_{act}}\right) \times \left(\frac{T_{act}}{T_{cal}}\right)}$$

Where:

Q_{act} = actual flow rate
Q_{cal} = calibrated flow rate (if a rotameter was used, the rotameter value)
P_{cal} = uncorrected air pressure at calibration
P_{act} = uncorrected air pressure at sampling site
T_{act} = temperature at sampling site (K)
T_{cal} = temperature at calibration (K)

Walton-Beckett Graticule

When ordering the Graticule for asbestos counting, specify the exact disc diameter needed to fit the ocular of the microscope and the diameter (mm) of the circular counting area. Instructions for measuring the dimensions necessary are listed:

(1) Insert any available graticule into the focusing eyepiece and focus so that the graticule lines are sharp and clear.

(2) Align the microscope.

(3) Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.

(4) Measure the magnified grid length, PL (μm), using the stage micrometer.

(5) Remove the graticule from the microscope and measure its actual grid length, AL (mm). This can be accomplished by using a mechanical stage fitted with verniers, or a jeweler's loupe with a direct reading scale.

(6) Let D=100 μm. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule and specify the diameter when making a purchase:

$$d_c = \frac{AL \times D}{PL}$$

Example: If PL=108 μm, AL=2.93 mm and D=100 μm, then,

$$d_c = \frac{2.93 \times 100}{108} = 2.71\text{mm}$$

(7) Each eyepiece-objective-reticle combination on the microscope must be calibrated. Should any of the three be changed (by zoom adjustment, disassembly, replacement, etc.), the combination must be recalibrated. Calibration may change if interpupillary distance is changed.

Measure the field diameter, D (acceptable range: 100 ±2 μm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine the field area (mm^2).

Field Area= $\pi(D/2)^2$
If D=100 μm=0.1 mm, then
Field Area=$\pi(0.1\text{ mm}/2)^2$=0.00785 mm^2

The Graticule is available from: Graticules Ltd., Morley Road, Tonbridge TN9 IRN, Kent, England (Telephone 011–44–732–359061). Also available from PTR Optics Ltd., 145 Newton Street, Waltham, MA 02154 [telephone (617) 891–6000] or McCrone Accessories and Components, 2506 S. Michigan Ave., Chicago, IL 60616 [phone (312) 842–7100]. The graticule is custom made for each microscope.

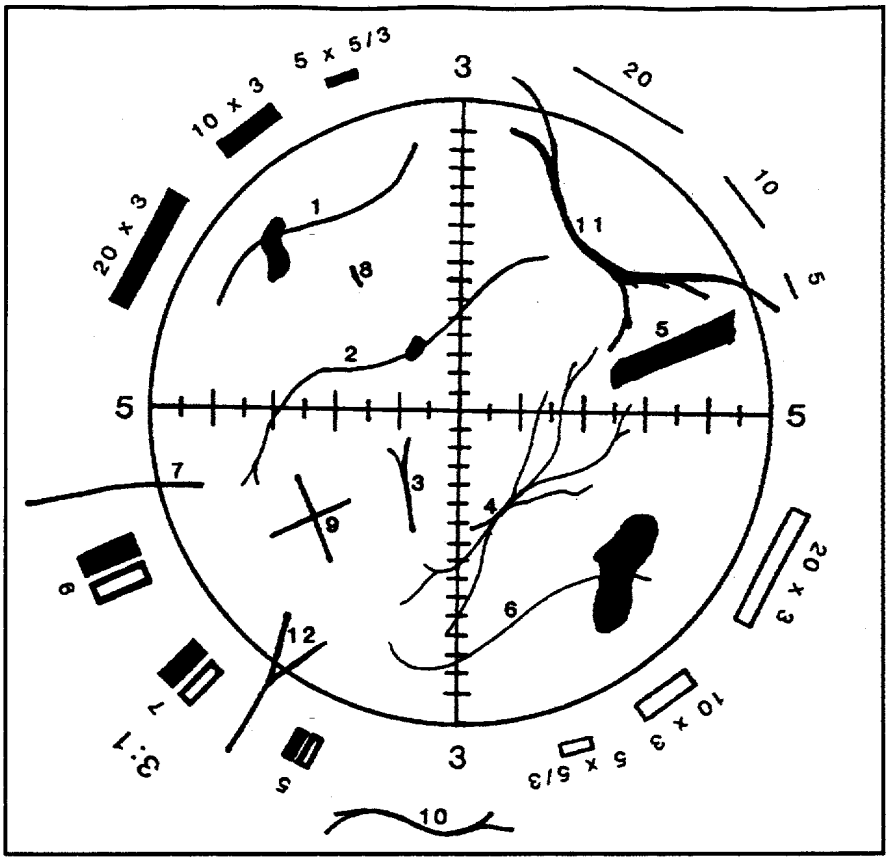

Figure 1: Walton-Beckett Graticule with some explanatory fibers.

COUNTS FOR THE FIBERS IN THE FIGURE

Structure No.	Count	Explanation
1 to 6	1	Single fibers all contained within the circle.
7	½	Fiber crosses circle once.
8	0	Fiber too short.
9	2	Two crossing fibers.
10	0	Fiber outside graticule.
11	0	Fiber crosses graticule twice.
12	½	Although split, fiber only crosses once.

APPENDIX C TO § 1915.1001—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 performed, 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 #6 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 a 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 #4 above shall be performed for at least one minute.

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

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

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

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

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

IAA concentration buildup in the test chamber during subsequent tests.

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

15. Persons who have successfully passed this fit test with a half-mask respirator may be assigned the use of the test respirator in atmospheres with up to 10 times the PEL of airborne asbestos. In atmospheres greater than 10 times, and less than 100 times the PEL (up to 100 ppm), the subject must pass the IAA test using a full face negative pressure respirator. (The concentration of the 1AA inside the test chamber must be increased by ten times for QLFT of the full facepiece.)

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

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

18. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician trained in respirator diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing her or his duties.

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

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

(1) Weight change of 20 pounds or more,

(2) Significant facial scarring in the area of the facepiece seal,

(3) Significant dental changes; i.e.; multiple extractions without prothesis, 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 a least 10 minutes before starting the fit test.

4. The test subject shall don the enclosure while wearing the respirator selected in section IB 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 to 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 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. 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 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 prothesis, 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 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 combination of high-efficiency and acid-gas cartridges.

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.

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.

7. The test conductor shall direct the stream of irritant smoke from the tube towards the faceseal 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. 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.

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 end 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 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.

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 prothesis, 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 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 non-powered air-purifying respirators only.

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

2. *Definition*

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

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

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

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

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

3. Apparatus

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

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

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

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

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

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

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

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

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

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

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

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

4. Procedural Requirements

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

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

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

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

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

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

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

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

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

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

1. Respirator restraining straps may not be over-tightened for testing. The straps shall be adjusted by the wearer to give a reasonably comfortable fit typical of normal use.

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

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

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

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

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

e. *Reading (R)*. The subject shall read out slowly and loud so as to be heard clearly by the test conductor or monitor. The test subject shall read the ''rainbow passage'' at the end of this section.

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 the three required tests are terminated, the fit shall be deemed inadequate. (See paragraph 4.h.).

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 prothesis, 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 in 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).

APPENDIX D TO § 1915.1001—MEDICAL QUESTIONNAIRES. MANDATORY

This mandatory appendix contains the medical questionnaires that must be administered to all employees who are exposed to asbestos, tremolite, anthophyllite, actinolite, or a combination of these minerals above the permissible exposure limit (0.1 f/cc), 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.

Part 1

INITIAL MEDICAL QUESTIONNAIRE

1. NAME _____

2. SOCIAL SECURITY #_____

3. CLOCK NUMBER_____

4. PRESENT OCCUPATION _____

5. PLANT _____

6. ADDRESS _____

7. _____
(Zip Code)

8. TELEPHONE NUMBER _____

9. INTERVIEWER _____

10. DATE _____

11. Date of Birth _____
Month Day Year

12. Place of Birth _____

13. Sex
1. Male ___
2. Female ___

14. What is your marital status?
1. Single ___
2. Married ___
3. Widowed ___
4. Separated/ Divorced _

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

16. What is the highest grade completed in school? _____

(For example 12 years is completion of high school)

OCCUPATIONAL HISTORY

17A. Have you ever worked full time (30 hours per week or more) for 6 months or more? 1. Yes _ 2. No__

IF YES TO 17A:

B. Have you ever worked for a year or more in any dusty job? 1. Yes__ 2.No__ 3.Does Not Apply _

Specify job/industry _____ Total Years Worked __

Was dust exposure: 1. Mild ___ 2. Moderate ___ 3. Severe ___

C. Have you even been exposed to gas or chemical fumes in your work? 1. Yes ___ 2. No ___

Specify job/industry _____ Total Years Worked ___

Was exposure: 1. Mild ___ 2. Moderate ___ 3. Severe ___

D. What has been your usual occupation or job--the one you have worked at the longest?

1. Job occupation _____

2. Number of years employed in this occupation _____

3. Position/job title _____

4. Business, field or industry _____

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

Have you ever worked:

		YES	NO
E.	In a mine?.....	[__]	[__]
F.	In a quarry?.....	[__]	[__]
G.	In a foundry?.....	[__]	[__]
H.	In a pottery?.....	[__]	[__]
I.	In a cotton, flax or hemp mill?.....	[__]	[__]
J.	With asbestos?.....	[__]	[__]

18. PAST MEDICAL HISTORY

		YES	NO
A.	Do you consider yourself to be in good health?	[__]	[__]
	If "NO" state reason _____		
B.	Have you any defect of vision?.....	[__]	[__]
	If "YES" state nature of defect _____		
C.	Have you any hearing defect?.....	[__]	[__]
	If "YES" state nature of defect _____		
D.	Are you suffering from or have you ever suffered from:	YES	NO
	a. Epilepsy (or fits, seizures, convulsions)?	[__]	[__]
	b. Rheumatic fever?	[__]	[__]
	c. Kidney disease?	[__]	[__]
	d. Bladder disease?	[__]	[__]
	e. Diabetes?	[__]	[__]
	f. Jaundice?	[__]	[__]

19. CHEST COLDS AND CHEST ILLNESSES

19A. If you get a cold, does it usually go to your chest? (Usually means more than 1/2 the time)
1. Yes__ 2. No__ 3. Don't get colds__

20A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed?
1. Yes__ 2. No__

IF YES TO 20A:

B. Did you produce phlegm with any of these chest illnesses?
1. Yes__ 2. No__ 3. Does Not Apply __

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

21. Did you have any lung trouble before the age of 16?
1. Yes__ 2. No__

22. Have you ever had any of the following?

1A. Attacks of bronchitis? 1. Yes__ 2. No__
IF YES TO 1A:
B. Was it confirmed by a doctor? 1. Yes__ 2. No__ 3. Does Not Apply _

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

2A. Pneumonia (include bronchopneumonia)? 1. Yes_ 2. No_
IF YES TO 2A:
B. Was it confirmed by a doctor? 1. Yes__ 2. No__ 3. Does Not Apply _

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

3A. Hay Fever? 1. Yes__ 2. No__
IF YES TO 3A:
B. Was it confirmed by a doctor? 1. Yes__ 2. No__ 3. Does Not Apply _

C. At what age did it start? Age in Years __ Does Not Apply _

23A. Have you ever had chronic bronchitis? 1. Yes__ 2. No__
IF YES TO 23A:
B. Do you still have it? 1. Yes __ 2. No__ 3. Does Not Apply _
C. Was it confirmed by a doctor? 1. Yes__ 2. No__ 3. Does Not Apply _

D. At what age did it start? Age in Years __ Does Not Apply _

24A. Have you ever had emphysema? 1. Yes__ 2. No__
IF YES TO 24A:
B. Do you still have it? 1. Yes__ 2. No__ 3. Does Not Apply _

C. Was it confirmed by a doctor? 1. Yes__ 2. No__ 3. Does Not Apply _

D. At what age did it start? Age in Years __ Does Not Apply _

25A. Have you ever had asthma? 1. Yes__ 2. No__
IF YES TO 25A:

B. Do you still have it? 1. Yes__ 2. No__
3. Does Not Apply _

C. Was it confirmed by a doctor? 1. Yes__ 2. No__
3. Does Not Apply _

D. At what age did it start? Age in Years __
Does Not Apply _

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

26. Have you ever had:

A. Any other chest illness? 1. Yes__ 2. No__

If yes, please specify _____

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) __ __ __ __

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.
Chronic bronchitis?	___	___	___	___	___	___
Emphysema?	___	___	___	___	___	___
Asthma?	___	___	___	___	___	___
Lung cancer?	___	___	___	___	___	___
Other chest conditions?	___	___	___	___	___	___
F. Is parent currently alive?	___	___	___	___	___	___

G. Please Specify ___ Age if Living ___ Age at Death ___ Don't Know ___ Age if Living ___ Age at Death ___ Don't Know

H. Please specify cause of death _____ _____

COUGH

32A. Do you usually have a cough? (Count 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 __

32B. 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 __

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 medicine for the(se) attack(s)?
1. Yes __ 2. No __
3.Does not apply __

BREATHLESSNESS

37. If disabled from walking by any condition other than heart or lung disease, pleasedescribe 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 age)?
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 __

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?
1. Yes__ 2. No__
(Yes means more than 1 cigar a week for a year)

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 _

Signature _____ Date _____

Part 2
PERIODIC MEDICAL QUESTIONNAIRE

1. NAME _____

2. SOCIAL SECURITY # __ __ __ __ __ __ __ __ __

3. CLOCK NUMBER __ __ __ __ __ __

4. PRESENT OCCUPATION _____

5. PLANT _____

6. ADDRESS _____

7. _____
(Zip Code)

8. TELEPHONE NUMBER _____

9. INTERVIEWER _____

10. DATE _____ __ __ __ __ __ __

11. What is your marital status? 1. Single __ 2. Married __ 3. Widowed __ 4. Separated/ Divorced _

12. OCCUPATIONAL HISTORY

12A. In the past year, did you work full time (30 hours per week or more) for 6 months or more? 1. Yes ___ 2. No __

IF YES TO 12A:

12B. In the past year, did you work in a dusty job? 1. Yes ___ 2. No __ 3. Does Not Apply ___

12C. Was dust exposure: 1. Mild __ 2. Moderate __ 3. Severe ___

12D. In the past year, were you exposed to gas or chemical fumes in your work? 1. Yes ___ 2. No ___

12E. Was exposure: 1. Mild __ 2.Moderate __ 3. Severe __

12F. In the past year, what was your:
1. Job/occupation? _____
2. Position/job title? _____

13. RECENT MEDICAL HISTORY

13A. Do you consider yourself to be in good health? Yes ___ No ___

If NO, state reason _____

13B. In the past year, have you developed:

	Yes	No
Epilepsy?	___	___
Rheumatic fever?	___	___
Kidney disease?	___	___
Bladder disease?	___	___
Diabetes?	___	___
Jaundice?	___	___
Cancer?	___	___

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:

	Yes or No	Further Comment on Positive Answers
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 or stairs	_____	

Do you:

Wheeze	_____
Cough up phlegm	_____

Smoke cigarettes _____ Packs per day __ How many years __

Date _____ Signature _____

APPENDIX E TO § 1915.1001—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.

APPENDIX F TO § 1915.1001—WORK PRACTICES AND ENGINEERING CONTROLS FOR CLASS I ASBESTOS OPERATIONS NON-MANDATORY

This is a non-mandatory appendix to the asbestos standards for construction and for shipyards. It describes criteria and procedures for erecting and using negative pressure enclosures for Class I Asbestos Work, when NPEs are used as an allowable control method to comply with paragraph (g)(5) (i) of this section. Many small and variable details are involved in the erection of a negative pressure enclosure. OSHA and most participants in the rulemaking agreed that only the major, more performance oriented criteria should be made mandatory. These criteria are set out in paragraph (g) of this section. In addition, this appendix includes these mandatory specifications and procedures in its guidelines in order to make this appendix coherent and helpful. The mandatory nature of the criteria which appear in the regulatory text is not changed because they are included in this ''non-mandatory'' appendix. Similarly, the additional criteria and procedures included as guidelines in the appendix, do not become mandatory because mandatory criteria are also included in these comprehensive guidelines.

In addition, none of the criteria, both mandatory and recommended, are meant to specify or imply the need for use of patented or licensed methods or equipment. Recommended specifications included in this attachment should not discourage the use of creative alternatives which can be shown to reliably achieve the objectives of negative-pressure enclosures.

Requirements included in this appendix, cover general provisions to be followed in all asbestos jobs, provisions which must be followed for all Class I asbestos jobs, and provisions governing the construction and testing of negative pressure enclosures. The first category includes the requirement for use of wet methods, HEPA vacuums, and immediate bagging of waste; Class I work must conform to the following provisions:

- oversight by competent person
- use of critical barriers over all openings to work area
- isolation of HVAC systems
- use of impermeable dropcloths and coverage of all objects within regulated areas

In addition, more specific requirements for NPEs include:

- maintenance of −0.02 inches water gauge within enclosure
- manometric measurements
- air movement away from employees performing removal work
- smoke testing or equivalent for detection of leaks and air direction
- deactivation of electrical circuits, if not provided with ground-fault circuit interrupters.

Planning the Project

The standard requires that an exposure assessment be conducted before the asbestos job is begun § 1915.1001(f)(1). Information needed for that assessment, includes data relating to prior similar jobs, as applied to the specific variables of the current job. The information needed to conduct the assessment will be useful in planning the project, and in complying with any reporting requirements under this standard, when significant changes are being made to a control system listed in the standard, [see paragraph (k) of this section], as well as those of USEPA (40 CFR part 61, subpart M). Thus, although the standard does not explicitly require the preparation of a written asbestos removal plan, the usual constituents of such a plan, i.e., a description of the enclosure, the equipment, and the procedures to be used throughout the project, must be determined before the enclosure can be erected. The following information should be included in the planning of the system:

A physical description of the work area;

A description of the approximate amount of material to be removed;

A schedule for turning off and sealing existing ventilation systems;

Personnel hygiene procedures;

A description of personal protective equipment and clothing to worn by employees;

A description of the local exhaust ventilation systems to be used and how they are to be tested;

A description of work practices to be observed by employees;

An air monitoring plan;

A description of the method to be used to transport waste material; and

The location of the dump site.

Materials and Equipment Necessary for Asbestos Removal

Although individual asbestos removal projects vary in terms of the equipment required to accomplish the removal of the materials, some equipment and materials are common to most asbestos removal operations.

Plastic sheeting used to protect horizontal surfaces, seal HVAC openings or to seal vertical openings and ceilings should have a minimum thickness of 6 mils. Tape or other adhesive used to attach plastic sheeting should be of sufficient adhesive strength to support the weight of the material plus all stresses encountered during the entire duration of the project without becoming detached from the surface.

Other equipment and materials which should be available at the beginning of each project are:

—HEPA Filtered Vacuum is essential for cleaning the work area after the asbestos has been removed. It should have a long hose capable of reaching out-of-the-way places, such as areas above ceiling tiles, behind pipes, etc.

—Portable air ventilation systems installed to provide the negative air pressure and air removal from the enclosure must be equipped with a HEPA filter. The number and capacity of units required to ventilate an enclosure depend on the size of the area to be ventilated. The filters for these systems should be designed in such a manner that they can be replaced when the air flow volume is reduced by the build-up of dust in the filtration material. Pressure monitoring devices with alarms and strip chart recorders attached to each system to indicate the pressure differential and the loss due to dust buildup on the filter are recommended.

—Water sprayers should be used to keep the asbestos material as saturated as possible during removal; the sprayers will provide a fine mist that minimizes the impact of the spray on the material.

—Water used to saturate the asbestos containing material can be amended by adding at least 15 milliliters (¼ ounce) of wetting agent in 1 liter (1 pint) of water. An example of a wetting agent is a 50/50 mixture of polyoxyethylene ether and polyoxyethylene polyglycol ester.

—Backup power supplies are recommended, especially for ventilation systems.

—Shower and bath water should be with mixed hot and cold water faucets. Water that has been used to clean personnel or equipment should either be filtered or be collected and discarded as asbestos waste. Soap and shampoo should be provided to aid in removing dust from the workers' skin and hair.

—See paragraphs (h) and (i) of this section for appropriate respiratory protection and protective clothing.

—See paragraph (k) of this section for required signs and labels.

Preparing the Work Area

Disabling HVAC Systems: The power to the heating, ventilation, and air conditioning systems that service the restricted area must be deactivated and locked off. All ducts, grills, access ports, windows and vents must be sealed off with two layers of plastic to prevent entrainment of contaminated air.

Operating HVAC Systems in the Restricted Area: If components of a HVAC system located in the restricted area are connected to a system that will service another zone during the project, the portion of the duct in the restricted area must be sealed and pressurized. Necessary precautions include caulking the duct joints, covering all cracks and openings with two layers of sheeting, and pressurizing the duct throughout the duration of the project by restricting the return air flow. The power to the fan supplying the positive pressure should be locked ''on'' to prevent pressure loss.

Sealing Elevators: If an elevator shaft is located in the restricted area, it should be either shut down or isolated by sealing with two layers of plastic sheeting. The sheeting should provide enough slack to accommodate the pressure changes in the shaft without breaking the air-tight seal.

Removing Mobile Objects: All movable objects should be cleaned and removed from the work area before an enclosure is constructed unless moving the objects creates a hazard. Mobile objects will be assumed to be contaminated and should be either cleaned with amended water and a HEPA vacuum and then removed from the area or wrapped and then disposed of as hazardous waste.

Cleaning and Sealing Surfaces: After cleaning with water and a HEPA vacuum, surfaces of stationary objects should be covered with two layers of plastic sheeting. The sheeting should be secured with duct tape or an equivalent method to provide a tight seal around the object.

Bagging Waste: In addition to the requirement for immediate bagging of waste for disposal, it is further recommended that the waste material be double-bagged and sealed in plastic bags designed for asbestos disposal. The bags should be stored in a waste storage area that can be controlled by the workers conducting the removal. Filters removed from air handling units and rubbish removed from the area are to be bagged and handled as hazardous waste.

Constructing the Enclosure

The enclosure should be constructed to provide an air-tight seal around ducts and

openings into existing ventilation systems and around penetrations for electrical conduits, telephone wires, water lines, drain pipes, etc. Enclosures should be both airtight and watertight except for those openings designed to provide entry and/or air flow control.

Size: An enclosure should be the minimum volume to encompass all of the working surfaces yet allow unencumbered movement by the worker(s), provide unrestricted air flow past the worker(s), and ensure walking surfaces can be kept free of tripping hazards.

Shape: The enclosure may be any shape that optimizes the flow of ventilation air past the worker(s).

Structural Integrity: The walls, ceilings and floors must be supported in such a manner that portions of the enclosure will not fall down during normal use.

Openings: It is not necessary that the structure be airtight; openings may be designed to direct air flow. Such openings should be located at a distance from active removal operations. They should be designed to draw air into the enclosure under all anticipated circumstances. In the event that negative pressure is lost, they should be fitted with either HEPA filters to trap dust or automatic trap doors that prevent dust from escaping the enclosure. Openings for exits should be controlled by an airlock or a vestibule.

Barrier Supports: Frames should be constructed to support all unsupported spans of sheeting.

Sheeting: Walls, barriers, ceilings, and floors should be lined with two layers of plastic sheeting having a thickness of at least 6 mil.

Seams: Seams in the sheeting material should be minimized to reduce the possibilities of accidental rips and tears in the adhesive or connections. All seams in the sheeting should overlap, be staggered and not be located at corners or wall-to- floor joints. Areas Within an Enclosure: Each enclosure consists of a work area, a decontamination area, and waste storage area. The work area where the asbestos removal operations occur should be separated from both the waste storage area and the contamination control area by physical curtains, doors, and/or airflow patterns that force any airborne contamination back into the work area.

See paragraph (j) of §1915.1001 for requirements for hygiene facilities.

During egress from the work area, each worker should step into the equipment room, clean tools and equipment, and remove gross contamination from clothing by wet cleaning and HEPA vacuuming. Before entering the shower area, foot coverings, head coverings, hand coverings, and coveralls are removed and placed in impervious bags for disposal or cleaning. Airline connections from airline respirators with HEPA disconnects and power cables from powered air-purifying respirators (PAPRs) will be disconnected just prior to entering the shower room.

Establishing Negative Pressure Within the Enclosure

Negative Pressure: Air is to be drawn into the enclosure under all anticipated conditions and exhausted through a HEPA filter for 24 hours a day during the entire duration of the project.

Air Flow Tests: Air flow patterns will be checked before removal operations begin, at least once per operating shift and any time there is a question regarding the integrity of the enclosure. The primary test for air flow is to trace air currents with smoke tubes or other visual methods. Flow checks are made at each opening and at each doorway to demonstrate that air is being drawn into the enclosure and at each worker's position to show that air is being drawn away from the breathing zone.

Monitoring Pressure Within the Enclosure: After the initial air flow patterns have been checked, the static pressure must be monitored within the enclosure. Monitoring may be made using manometers, pressure gauges, or combinations of these devices. It is recommended that they be attached to alarms and strip chart recorders at points identified by the design engineer.

Corrective Actions: If the manometers or pressure gauges demonstrate a reduction in pressure differential below the required level, work should cease and the reason for the change investigated and appropriate changes made. The air flow patterns should be retested before work begins again.

Pressure Differential: The design parameters for static pressure differentials between the inside and outside of enclosures typically range from 0.02 to 0.10 inches of water gauge, depending on conditions. All zones inside the enclosure must have less pressure than the ambient pressure outside of the enclosure (–0.02 inches water gauge differential). Design specifications for the differential vary according to the size, configuration, and shape of the enclosure as well as ambient and mechanical air pressure conditions around the enclosure.

Air Flow Patterns: The flow of air past each worker shall be enhanced by positioning the intakes and exhaust ports to remove contaminated air from the worker's breathing zone, by positioning HEPA vacuum cleaners to draw air from the worker's breathing zone, by forcing relatively uncontaminated air past the worker toward an exhaust port, or by using a combination of methods to reduce the worker's exposure.

Air Handling Unit Exhaust: The exhaust plume from air handling units should be located away from adjacent personnel and intakes for HVAC systems.

Air Flow Volume: The air flow volume (cubic meters per minute) exhausted (removed) from the workplace must exceed the amount of makeup air supplied to the enclosure. The rate of air exhausted from the enclosure should be designed to maintain a negative pressure in the enclosure and air movement past each worker. The volume of air flow removed from the enclosure should replace the volume of the container at every 5 to 15 minutes. Air flow volume will need to be relatively high for large enclosures, enclosures with awkward shapes, enclosures with multiple openings, and operations employing several workers in the enclosure.

Air Flow Velocity: At each opening, the air flow velocity must visibly ''drag'' air into the enclosure. The velocity of air flow within the enclosure must be adequate to remove airborne contamination from each worker's breathing zone without disturbing the asbestos-containing material on surfaces.

Airlocks: Airlocks are mechanisms on doors and curtains that control the air flow patterns in the doorways. If air flow occurs, the patterns through doorways must be such that the air flows toward the inside of the enclosure. Sometimes vestibules, double doors, or double curtains are used to prevent air movement through the doorways. To use a vestibule, a worker enters a chamber by opening the door or curtain and then closing the entry before opening the exit door or curtain.

Airlocks should be located between the equipment room and shower room, between the shower room and the clean room, and between the waste storage area and the outside of the enclosure. The air flow between adjacent rooms must be checked using smoke tubes or other visual tests to ensure the flow patterns draw air toward the work area without producing eddies.

Monitoring for Airborne Concentrations

In addition to the breathing zone samples taken as outlined in paragraph (f) of § 1915.1001 , samples of air should be taken to demonstrate the integrity of the enclosure, the cleanliness of the clean room and shower area, and the effectiveness of the HEPA filter. If the clean room is shown to be contaminated, the room must be relocated to an uncontaminated area.

Samples taken near the exhaust of portable ventilation systems must be done with care.

General Work Practices

Preventing dust dispersion is the primary means of controlling the spread of asbestos within the enclosure. Whenever practical, the point of removal should be isolated, enclosed, covered, or shielded from the workers in the area. Waste asbestos containing materials must be bagged during or immediately after removal; the material must remain saturated until the waste container is sealed.

Waste material with sharp points or corners must be placed in hard air-tight containers rather than bags.

Whenever possible, large components should be sealed in plastic sheeting and removed intact.

Bags or containers of waste will be moved to the waste holding area, washed, and wrapped in a bag with the appropriate labels.

Cleaning the Work Area

Surfaces within the work area should be kept free of visible dust and debris to the extent feasible. Whenever visible dust appears on surfaces, the surfaces within the enclosure must be cleaned by wiping with a wet sponge, brush, or cloth and then vacuumed with a HEPA vacuum.

All surfaces within the enclosure should be cleaned before the exhaust ventilation system is deactivated and the enclosure is disassembled. An approved encapsulant may be sprayed onto areas after the visible dust has been removed.

APPENDIX G TO § 1915.1001 [RESERVED]

APPENDIX H TO § 1915.1001—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, anthophyllite asbestos, tremolite asbestos, and actinolite asbestos.

B. Asbestos is and was 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 an asbestos-containing product to release breathable fibers depends largely 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 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 felt are considered nonfriable if intact and generally do not emit airborne fibers unless subjected to sanding, sawing and other aggressive operations. Asbestos—cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken.

D. Permissible exposure: Exposure to airborne asbestos fibers may not exceed 0.1 fibers per cubic centimeter of air (0.1 f/cc) averaged over the 8-hour workday, and 1 fiber per cubic centimeter of air (1.0 f/cc) averaged over a 30 minute work period.

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 0.1 f/cc and when performing certain designated operations. Air-purifying respirators equipped with a high-efficiency particulate air (HEPA) filter can be used where airborne asbestos fiber concentrations do not exceed 1.0 f/cc; otherwise, more protective respirators such as 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 a fit test 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 0.1 f/cc.

IV. Disposal Procedures and Clean-up

A. Wastes that are generated by processes where asbestos is present include:

1. Empty asbestos shipping containers.
2. Process wastes such as cuttings, trimmings, or reject materials.
3. Housekeeping waste from wet-sweeping or HEPA-vacuuming.
4. Asbestos fireproofing or insulating material that is removed from buildings.
5. Asbestos-containing building products 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. Asbestos-containing material that is removed from buildings must be disposed of in leak-tight 6-mil 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 asbestos-containing materials, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to asbestos. Your employer must treat exposure to thermal system insulation and sprayed-on and troweled-on surfacing material as asbestos exposure, unless results of laboratory analysis show that the material does not contain 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 exposure 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.

APPENDIX I TO §1915.1001—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 characteristics 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 sates 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 have 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 a 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 at or above the permissible exposure limits (0.1 fiber per cubic centimeter of air) for 30 or more days per year and for all employees who are assigned to wear a negative-pressure respirator. All examinations and procedures must be performed by or under the supervision of licensed physician at a reasonable time and place, and at no cost to the employee.

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

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

(ii) Completion of the respiratory disease questionnaire contained in appendix D to this section.

(iii) A physical examination including a chest roentgenogram and pulmonary function test that include measurement of the employee's forced vital capacity (FYC) and forced expiratory volume at one second (FEV_1).

(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.

APPENDIX J TO §1915.1001—SMOKING CESSATION PROGRAM INFORMATION FOR ASBESTOS—NON-MANDATORY

The following organizations provide smoking cessation information.

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, N.E., Atlanta, Georgia 30026, (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) conducted numerous public information programs about the health effects of smoking. ALA 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 (OSHA) is the Department of Health and Human Services' lead agency in smoking control. OSHA 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 524–1234 (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 201), New York, and Texas. Consult your local telephone directory for listings of local chapters.

APPENDIX K TO §1915.1001—POLARIZED LIGHT MICROSCOPY OF ASBESTOS—NON-MANDATORY

Method number: ID–191
Matrix: Bulk

Collection Procedure

Collect approximately 1 to 2 grams of each type of material and place into separate 20 mL scintillation vials.

Analytical Procedure

A portion of each separate phase is analyzed by gross examination, phase-polar examination, and central stop dispersion microscopy.

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL-OSHA. Similar products from other sources may be substituted.

1. Introduction

This method describes the collection and analysis of asbestos bulk materials by light microscopy techniques including phase-polar illumination and central-stop dispersion microscopy. Some terms unique to asbestos analysis are defined below:

Amphibole: A family of minerals whose crystals are formed by long, thin units which have two thin ribbons of double chain silicate with a brucite ribbon in between. The shape of each unit is similar to an ''I beam''. Minerals important in asbestos analysis include cummingtonite-grunerite, crocidolite, tremolite- actinolite and anthophyllite.

Asbestos: A term for naturally occurring fibrous minerals. Asbestos includes chrysotile, cummingtonite-grunerite asbestos (amosite), anthophyllite asbestos, tremolite asbestos, crocidolite, actinolite asbestos and any of these minerals which have been chemically treated or altered. The precise chemical formulation of each species varies with the location from which it was mined. Nominal compositions are listed:

Chrysotile.....Mg_3 Si_2 $O_5(OH)_4$
Crocidolite (Riebeckite asbestos)
.....$Na_2Fe_32+Fe_23+Si_8O_{22}(OH)_2$
Cummingtonite-Grunerite asbestos
(Amosite).....$(Mg,Fe)_7$ $Si_8O_{22}(OH)_2$
Tremolite-Actinolite asbestos
..... $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
Anthophyllite asbestos...$(Mg,Fe)_7$ $Si_8O_{22}(OH)_2$

Asbestos Fiber: A fiber of asbestos meeting the criteria for a fiber. (See section 3.5.)

Aspect Ratio: The ratio of the length of a fiber to its diameter usually defined as ''length : width'', e.g. 3:1.

Brucite: A sheet mineral with the composition $Mg(OH)_2$.

Central Stop Dispersion Staining (microscope): This is a dark field microscope technique that images particles using only light refracted by the particle, excluding light that travels through the particle unrefracted. This is usually accomplished with a McCrone objective or other arrangement which places a circular stop with apparent aperture equal to the objective aperture in the back focal plane of the microscope.

Cleavage Fragments: Mineral particles formed by the comminution of minerals, especially those characterized by relatively parallel sides and moderate aspect ratio.

Differential Counting: The term applied to the practice of excluding certain kinds of fibers from a phase contrast asbestos count because they are not asbestos.

Fiber: A particle longer than or equal to 5 μm with a length to width ratio greater than or equal to 3:1. This may include cleavage fragments. (see section 3.5 of this appendix).

Phase Contrast: Contrast obtained in the microscope by causing light scattered by small particles to destructively interfere with unscattered light, thereby enhancing the visibility of very small particles and particles with very low intrinsic contrast.

Phase Contrast Microscope: A microscope configured with a phase mask pair to create phase contrast. The technique which uses this is called Phase Contrast Microscopy (PCM).

Phase-Polar Analysis: This is the use of polarized light in a phase contrast microscope. It is used to see the same size fibers that are visible in air filter analysis. Although fibers finer than 1 μm are visible, analysis of these is inferred from analysis of larger bundles that are usually present.

Phase-Polar Microscope: The phase-polar microscope is a phase contrast microscope which has an analyzer, a polarizer, a first order red plate and a rotating phase condenser all in place so that the polarized light image is enhanced by phase contrast.

Sealing Encapsulant: This is a product which can be applied, preferably by spraying, onto an asbestos surface which will seal the surface so that fibers cannot be released.

Serpentine: A mineral family consisting of minerals with the general composition $Mg_3(Si2O_5(OH)_4$ having the magnesium in brucite layer over a silicate layer. Minerals important in asbestos analysis included in this family are chrysotile, lizardite, antigorite.

1.1. History

Light microscopy has been used for well over 100 years for the determination of mineral species. This analysis is carried out using specialized polarizing microscopes as well as bright field microscopes. The identification of minerals is an on-going process with many new minerals described each year. The first recorded use of asbestos was in Finland about 2500 B.C. where the material was used in the mud wattle for the wooden huts the people lived in as well as strengthening for pottery. Adverse health aspects of the mineral were noted nearly 2000 years ago when Pliny the Younger wrote about the poor health of slaves in the asbestos mines. Although known to be injurious for centuries, the first modern references to its toxicity were by the British Labor Inspectorate when it banned asbestos dust from the workplace in 1898. Asbestosis cases were described in the literature after the turn of the century. Cancer was first suspected in the mid 1930's and a causal link to mesothelioma was made in 1965. Because of the public concern for worker and public safety with the use of this material, several different types of analysis were applied to the determination of asbestos content. Light microscopy requires a great deal of experience and craft. Attempts were made to apply less subjective methods to the analysis. X-ray diffraction was partially successful in determining the mineral types but was unable to separate out the fibrous portions

from the non-fibrous portions. Also, the minimum detection limit for asbestos analysis by X-ray diffraction (XRD) is about 1%. Differential Thermal Analysis (DTA) was no more successful. These provide useful corroborating information when the presence of asbestos has been shown by microscopy; however, neither can determine the difference between fibrous and non-fibrous minerals when both habits are present. The same is true of Infrared Absorption (IR).

When electron microscopy was applied to asbestos analysis, hundreds of fibers were discovered present too small to be visible in any light microscope. There are two different types of electron microscope used for asbestos analysis: Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Scanning Electron Microscopy is useful in identifying minerals. The SEM can provide two of the three pieces of information required to identify fibers by electron microscopy: morphology and chemistry. The third is structure as determined by Selected Area Electron Diffraction—SAED which is performed in the TEM. Although the resolution of the SEM is sufficient for very fine fibers to be seen, accuracy of chemical analysis that can be performed on the fibers varies with fiber diameter in fibers of less than 0.2 μ m diameter. The TEM is a powerful tool to identify fibers too small to be resolved by light microscopy and should be used in conjunction with this method when necessary. The TEM can provide all three pieces of information required for fiber identification. Most fibers thicker than 1 μ m can adequately be defined in the light microscope. The light microscope remains as the best instrument for the determination of mineral type. This is because the minerals under investigation were first described analytically with the light microscope. It is inexpensive and gives positive identification for most samples analyzed. Further, when optical techniques are inadequate, there is ample indication that alternative techniques should be used for complete identification of the sample.

1.2. Principle

Minerals consist of atoms that may be arranged in random order or in a regular arrangement. Amorphous materials have atoms in random order while crystalline materials have long range order. Many materials are transparent to light, at least for small particles or for thin sections. The properties of these materials can be investigated by the effect that the material has on light passing through it. The six asbestos minerals are all crystalline with particular properties that have been identified and cataloged. These six minerals are anisotropic. They have a regular array of atoms, but the arrangement is not the same in all directions. Each major direction of the crystal presents a different regularity. Light photons travelling in each of these main directions will encounter different electrical neighborhoods, affecting the path and time of travel. The techniques outlined in this method use the fact that light traveling through fibers or crystals in different directions will behave differently, but predictably. The behavior of the light as it travels through a crystal can be measured and compared with known or determined values to identify the mineral species. Usually, Polarized Light Microscopy (PLM) is performed with strain-free objectives on a bright-field microscope platform. This would limit the resolution of the microscope to about 0.4 μ m. Because OSHA requires the counting and identification of fibers visible in phase contrast, the phase contrast platform is used to visualize the fibers with the polarizing elements added into the light path. Polarized light methods cannot identify fibers finer than about 1μ m in diameter even though they are visible. The finest fibers are usually identified by inference from the presence of larger, identifiable fiber bundles. When fibers are present, but not identifiable by light microscopy, use either SEM or TEM to determine the fiber identity.

1.3. Advantages and Disadvantages

The advantages of light microcopy are:

(a) Basic identification of the materials was first performed by light microscopy and gross analysis. This provides a large base of published information against which to check analysis and analytical technique.

(b) The analysis is specific to fibers. The minerals present can exist in asbestiform, fibrous, prismatic, or massive varieties all at the same time. Therefore, bulk methods of analysis such as X-ray diffraction, IR analysis, DTA, etc. are inappropriate where the material is not known to be fibrous.

(c) The analysis is quick, requires little preparation time, and can be performed on-site if a suitably equipped microscope is available.

The disadvantages are:

(a) Even using phase-polar illumination, not all the fibers present may be seen. This is a problem for very low asbestos concentrations where agglomerations or large bundles of fibers may not be present to allow identification by inference.

(b) The method requires a great degree of sophistication on the part of the microscopist. An analyst is only as useful as his mental catalog of images. Therefore, a microscopist's accuracy is enhanced by experience. The mineralogical training of the analyst is very important. It is the basis on which subjective decisions are made.

(c) The method uses only a tiny amount of material for analysis. This may lead to sampling bias and false results (high or low).

This is especially true if the sample is severely inhomogeneous.

(d) Fibers may be bound in a matrix and not distinguishable as fibers so identification cannot be made.

1.4. Method Performance

1.4.1. This method can be used for determination of asbestos content from 0 to 100% asbestos. The detection limit has not been adequately determined, although for selected samples, the limit is very low, depending on the number of particles examined. For mostly homogeneous, finely divided samples, with no difficult fibrous interferences, the detection limit is below 1%. For inhomogeneous samples (most samples), the detection limit remains undefined. NIST has conducted proficiency testing of laboratories on a national scale. Although each round is reported statistically with an average, control limits, etc., the results indicate a difficulty in establishing precision especially in the low concentration range. It is suspected that there is significant bias in the low range especially near 1%. EPA tried to remedy this by requiring a mandatory point counting scheme for samples less than 10%. The point counting procedure is tedious, and may introduce significant biases of its own. It has not been incorporated into this method.

1.4.2. The precision and accuracy of the quantitation tests performed in this method are unknown. Concentrations are easier to determine in commercial products where asbestos was deliberately added because the amount is usually more than a few percent. An analyst's results can be ''calibrated'' against the known amounts added by the manufacturer. For geological samples, the degree of homogeneity affects the precision.

1.4.3. The performance of the method is analyst dependent. The analyst must choose carefully and not necessarily randomly the portions for analysis to assure that detection of asbestos occurs when it is present. For this reason, the analyst must have adequate training in sample preparation, and experience in the location and identification of asbestos in samples. This is usually accomplished through substantial on-the-job training as well as formal education in mineralogy and microscopy.

1.5. Interferences

Any material which is long, thin, and small enough to be viewed under the microscope can be considered an interference for asbestos. There are literally hundreds of interferences in workplaces. The techniques described in this method are normally sufficient to eliminate the interferences. An analyst's success in eliminating the interferences depends on proper training.

Asbestos minerals belong to two mineral families: the serpentines and the amphiboles. In the serpentine family, the only common fibrous mineral is chrysotile. Occasionally, the mineral antigorite occurs in a fibril habit with morphology similar to the amphiboles. The amphibole minerals consist of a score of different minerals of which only five are regulated by federal standard: amosite, crocidolite, anthophyllite asbestos, tremolite asbestos and actinolite asbestos. These are the only amphibole minerals that have been commercially exploited for their fibrous properties; however, the rest can and do occur occasionally in asbestiform habit.

In addition to the related mineral interferences, other minerals common in building material may present a problem for some microscopists: gypsum, anhydrite, brucite, quartz fibers, talc fibers or ribbons, wollastonite, perlite, attapulgite, etc. Other fibrous materials commonly present in workplaces are: fiberglass, mineral wool, ceramic wool, refractory ceramic fibers, kevlar, nomex, synthetic fibers, graphite or carbon fibers, cellulose (paper or wood) fibers, metal fibers, etc.

Matrix embedding material can sometimes be a negative interference. The analyst may not be able to easily extract the fibers from the matrix in order to use the method. Where possible, remove the matrix before the analysis, taking careful note of the loss of weight. Some common matrix materials are: vinyl, rubber, tar, paint, plant fiber, cement, and epoxy. A further negative interference is that the asbestos fibers themselves may be either too small to be seen in Phase contrast Microscopy (PCM) or of a very low fibrous quality, having the appearance of plant fibers. The analyst's ability to deal with these materials increases with experience.

1.6. Uses and Occupational Exposure

Asbestos is ubiquitous in the environment. More than 40% of the land area of the United States is composed of minerals which may contain asbestos. Fortunately, the actual formation of great amounts of asbestos is relatively rare. Nonetheless, there are locations in which environmental exposure can be severe such as in the Serpentine Hills of California.

There are thousands of uses for asbestos in industry and the home. Asbestos abatement workers are the most current segment of the population to have occupational exposure to great amounts of asbestos. If the material is undisturbed, there is no exposure. Exposure occurs when the asbestos-containing material is abraded or otherwise disturbed during maintenance operations or some other activity. Approximately 95% of the asbestos in place in the United States is chrysotile.

Amosite and crocidolite make up nearly all the difference. Tremolite and anthophyllite make up a very small percentage. Tremolite is found in extremely small

amounts in certain chrysotile deposits. Actinolite exposure is probably greatest from environmental sources, but has been identified in vermiculite containing, sprayed-on insulating materials which may have been certified as asbestos-free.

1.7. Physical and Chemical Properties

The nominal chemical compositions for the asbestos minerals were given in Section 1. Compared to cleavage fragments of the same minerals, asbestiform fibers possess a high tensile strength along the fiber axis. They are chemically inert, non-combustible, and heat resistant. Except for chrysotile, they are insoluble in Hydrochloric acid (HCl). Chrysotile is slightly soluble in HCl. Asbestos has high electrical resistance and good sound absorbing characteristics. It can be woven into cables, fabrics or other textiles, or matted into papers, felts, and mats.

1.8. Toxicology (This Section is for Information Only and Should Not Be Taken as OSHA Policy)

Possible physiologic results of respiratory exposure to asbestos are mesothelioma of the pleura or peritoneum, interstitial fibrosis, asbestosis, pneumoconiosis, or respiratory cancer. The possible consequences of asbestos exposure are detailed in the NIOSH Criteria Document or in the OSHA Asbestos Standards 29 CFR 1910.1001 and 29 CFR 1926.1101 and 29 CFR 1915.1001.

2. Sampling Procedure

2.1. Equipment for Sampling

(a) Tube or cork borer sampling device
(b) Knife
(c) 20 mL scintillation vial or similar vial
(d) Sealing encapsulant

2.2. Safety Precautions

Asbestos is a known carcinogen. Take care when sampling. While in an asbestos-containing atmosphere, a properly selected and fit-tested respirator should be worn. Take samples in a manner to cause the least amount of dust. Follow these general guidelines:

(a) Do not make unnecessary dust.
(b) Take only a small amount (1 to 2 g).
(c) Tightly close the sample container.
(d) Use encapsulant to seal the spot where the sample was taken, if necessary.

2.3. Sampling procedure

Samples of any suspect material should be taken from an inconspicuous place. Where the material is to remain, seal the sampling wound with an encapsulant to eliminate the potential for exposure from the sample site. Microscopy requires only a few milligrams of material. The amount that will fill a 20 mL scintillation vial is more than adequate. Be sure to collect samples from all layers and phases of material. If possible, make separate samples of each different phase of the material. This will aid in determining the actual hazard. *DO NOT USE ENVELOPES, PLASTIC OR PAPER BAGS OF ANY KIND TO COLLECT SAMPLES.* The use of plastic bags presents a contamination hazard to laboratory personnel and to other samples. When these containers are opened, a bellows effect blows fibers out of the container onto everything, including the person opening the container.

If a cork-borer type sampler is available, push the tube through the material all the way, so that all layers of material are sampled. Some samplers are intended to be disposable. These should be capped and sent to the laboratory. If a non-disposable cork borer is used, empty the contents into a scintillation vial and send to the laboratory. Vigorously and completely clean the cork borer between samples.

2.4 Shipment

Samples packed in glass vials must not touch or they might break in shipment.

(a) Seal the samples with a sample seal over the end to guard against tampering and to identify the sample.

(b) Package the bulk samples in separate packages from the air samples. They may cross-contaminate each other and will invalidate the results of the air samples.

(c) Include identifying paperwork with the samples, but not in contact with the suspected asbestos.

(d) To maintain sample accountability, ship the samples by certified mail, overnight express, or hand carry them to the laboratory.

3. Analysis

The analysis of asbestos samples can be divided into two major parts: sample preparation and microscopy. Because of the different asbestos uses that may be encountered by the analyst, each sample may need different preparation steps. The choices are outlined below. There are several different tests that are performed to identify the asbestos species and determine the percentage. They will be explained below.

3.1. Safety

(a) Do not create unnecessary dust. Handle the samples in HEPA-filter equipped hoods. If samples are received in bags, envelopes or other inappropriate container, open them only in a hood having a face velocity at or greater than 100 fpm. Transfer a small amount to a scintillation vial and only handle the smaller amount.

(b) Open samples in a hood, never in the open lab area.

(c) Index of refraction oils can be toxic. Take care not to get this material on the skin. Wash immediately with soap and water if this happens.

(d) Samples that have been heated in the muffle furnace or the drying oven may be hot. Handle them with tongs until they are cool enough to handle.

(e) Some of the solvents used, such as THF (tetrahydrofuran), are toxic and should only be handled in an appropriate fume hood and according to instructions given in the Material Safety Data Sheet (MSDS).

3.2. Equipment

(a) Phase contrast microscope with 10x, 16x and 40x objectives, 10x wide-field eyepieces, G–22 Walton-Beckett graticule, Whipple disk, polarizer, analyzer and first order red or gypsum plate, 100 Watt illuminator, rotating position condenser with oversize phase rings, central stop dispersion objective, Kohler illumination and a rotating mechanicalstage. (See figure 1).

(b) Stereo microscope with reflected light illumination, transmitted light illumination, polarizer, analyzer and first order red or gypsum plate, and rotating stage.

(c) Negative pressure hood for the stereo microscope

(d) Muffle furnace capable of 600 °C

(e) Drying oven capable of 50–150 °C

(f) Aluminum specimen pans

(g) Tongs for handling samples in the furnace

(h) High dispersion index of refraction oils (Special for dispersion staining.)

n = 1.550
n = 1.585
n = 1.590
n = 1.605
n = 1.620
n = 1.670
n = 1.680
n = 1.690

(i) A set of index of refraction oils from about n=1.350 to n=2.000 in n=0.005 increments. (Standard for Becke line analysis.)

(j) Glass slides with painted or frosted ends 1 x 3 inches 1mm thick, precleaned.

(k) Cover Slips 22 x 22 mm, #1½

(l) Paper clips or dissection needles

(m) Hand grinder

(n) Scalpel with both #10 and #11 blades

(o) 0.1 molar HCl

(p) Decalcifying solution (Baxter Scientific Products) Ethylenediaminetetraacetic Acid,

Tetrasodium .....0.7 g/l
Sodium Potassium Tartrate .....8.0 mg/liter
Hydrochloric Acid .....99.2 g/liter
Sodium Tartrate.....0.14 g/liter

(q) Tetrahydrofuran (THF)

(r) Hotplate capable of 60 °C

(s) Balance

(t) Hacksaw blade

(u) Ruby mortar and pestle

3.3. Sample Pre-Preparation

Sample preparation begins with pre-preparation which may include chemical reduction of the matrix, heating the sample to dryness or heating in the muffle furnace. The end result is a sample which has been reduced to a powder that is sufficiently fine to fit under the cover slip. Analyze different phases of samples separately, e.g., tile and the tile mastic should be analyzed separately as the mastic may contain asbestos while the tile may not.

(A) *Wet Samples*

Samples with a high water content will not give the proper dispersion colors and must be dried prior to sample mounting. Remove the lid of the scintillation vial, place the bottle in the drying oven and heat at 100 °C to dryness (usually about 2 h). Samples which are not submitted to the lab in glass must be removed and placed in glass vials or aluminum weighing pans before placing them in the drying oven.

(B) *Samples With Organic Interference—Muffle Furnace*

These may include samples with tar as a matrix, vinyl asbestos tile, or any other organic that can be reduced by heating. Remove the sample from the vial and weigh in a balance to determine the weight of the submitted portion. Place the sample in a muffle furnace at 500 °C for 1 to 2 h or until all obvious organic material has been removed. Retrieve, cool and weigh again to determine the weight loss on ignition. This is necessary to determine the asbestos content of the submitted sample, because the analyst will be looking at a reduced sample.

NOTES: Heating above 600 °C will cause the sample to undergo a structural change which, given sufficient time, will convert the chrysotile to forsterite. Heating even at lower temperatures for 1 to 2 h may have a measurable effect on the optical properties of the minerals. If the analyst is unsure of what to expect, a sample of standard asbestos should be heated to the same temperature for the same length of time so that it can be examined for the proper interpretation.

(C) *Samples With Organic Interference—THF*

Vinyl asbestos tile is the most common material treated with this solvent, although, substances containing tar will sometimes yield to this treatment. Select a portion of the material and then grind it up if possible. Weigh the sample and place it in a test tube. Add sufficient THF to dissolve the organic matrix. This is usually about 4 to 5 mL. *Remember, THF is highly flammable.* Filter the remaining material through a tared silver

membrane, dry and weigh to determine how much is left after the solvent extraction. Further process the sample to remove carbonate or mount directly.

(D) *Samples With Carbonate Interference*

Carbonate material is often found on fibers and sometimes must be removed in order to perform dispersion microscopy. Weigh out a portion of the material and place it in a test tube. Add a sufficient amount of 0.1 M HCl or decalcifying solution in the tube to react all the carbonate as evidenced by gas formation; i.e., when the gas bubbles stop, add a little more solution. If no more gas forms, the reaction is complete. Filter the material out through a tared silver membrane, dry and weigh to determine the weight lost.

3.4. Sample Preparation

Samples must be prepared so that accurate determination can be made of the asbestos type and amount present. The following steps are carried out in the low-flow hood (a low-flow hood has less than 50 fpm flow):

(1) If the sample has large lumps, is hard, or cannot be made to lie under a cover slip, the grain size must be reduced. Place a small amount between two slides and grind the material between them or grind a small amount in a clean mortar and pestle. The choice of whether to use an alumina, ruby, or diamond mortar depends on the hardness of the material. Impact damage can alter the asbestos mineral if too much mechanical shock occurs. (Freezer mills can completely destroy the observable crystallinity of asbestos and should not be used). For some samples, a portion of material can be shaved off with a scalpel, ground off with a hand grinder or hack saw blade.

The preparation tools should either be disposable or cleaned thoroughly. Use vigorous scrubbing to loosen the fibers during the washing. Rinse the implements with copious amounts of water and air-dry in a dust-free environment.

(2) If the sample is powder or has been reduced as in 1) above, it is ready to mount. Place a glass slide on a piece of optical tissue and write the identification on the painted or frosted end. Place two drops of index of refraction medium n=1.550 on the slide. (The medium n=1.550 is chosen because it is the matching index for chrysotile. Dip the end of a clean paper-clip or dissecting needle into the droplet of refraction medium *on the slide* to moisten it. Then dip the probe into the powder sample. Transfer what sticks on the probe to the slide. The material on the end of the probe should have a diameter of about 3 mm for a good mount. If the material is very fine, less sample may be appropriate. For non-powder samples such as fiber mats, forceps should be used to transfer a small amount of material to the slide. Stir the material in the medium on the slide, spreading it out and making the preparation as uniform as possible. Place a cover-slip on the preparation by gently lowering onto the slide and allowing it to fall ''trapdoor'' fashion on the preparation to push out any bubbles. Press gently on the cover slip to even out the distribution of particulate on the slide. If there is insufficient mounting oil on the slide, one or two drops may be placed near the edge of the coverslip on the slide. Capillary action will draw the necessary amount of liquid into the preparation. Remove excess oil with the point of a laboratory wiper.

Treat at least two different areas of each phase in this fashion. Choose representative areas of the sample. It may be useful to select particular areas or fibers for analysis. This is useful to identify asbestos in severely inhomogeneous samples.

When it is determined that amphiboles may be present, repeat the above process using the appropriate high- dispersion oils until an identification is made or all six asbestos minerals have been ruled out. Note that percent determination must be done in the index medium 1.550 because amphiboles tend to disappear in their matching mediums.

3.5. Analytical procedure

NOTE: This method presumes some knowledge of mineralogy and optical petrography.

The analysis consists of three parts: The determination of whether there is asbestos present, what type is present and the determination of how much is present. The general flow of the analysis is:

(1) Gross examination.

(2) Examination under polarized light on the stereo microscope.

(3) Examination by phase-polar illumination on the compound phase microscope.

(4) Determination of species by dispersion stain. Examination by Becke line analysis may also be used; however, this is usually more cumbersome for asbestos determination.

(5) Difficult samples may need to be analyzed by SEM or TEM, or the results from those techniques combined with light microscopy for a definitive identification. Identification of a particle as asbestos requires that it be asbestiform. Description of particles should follow the suggestion of Campbell. (Figure 1)

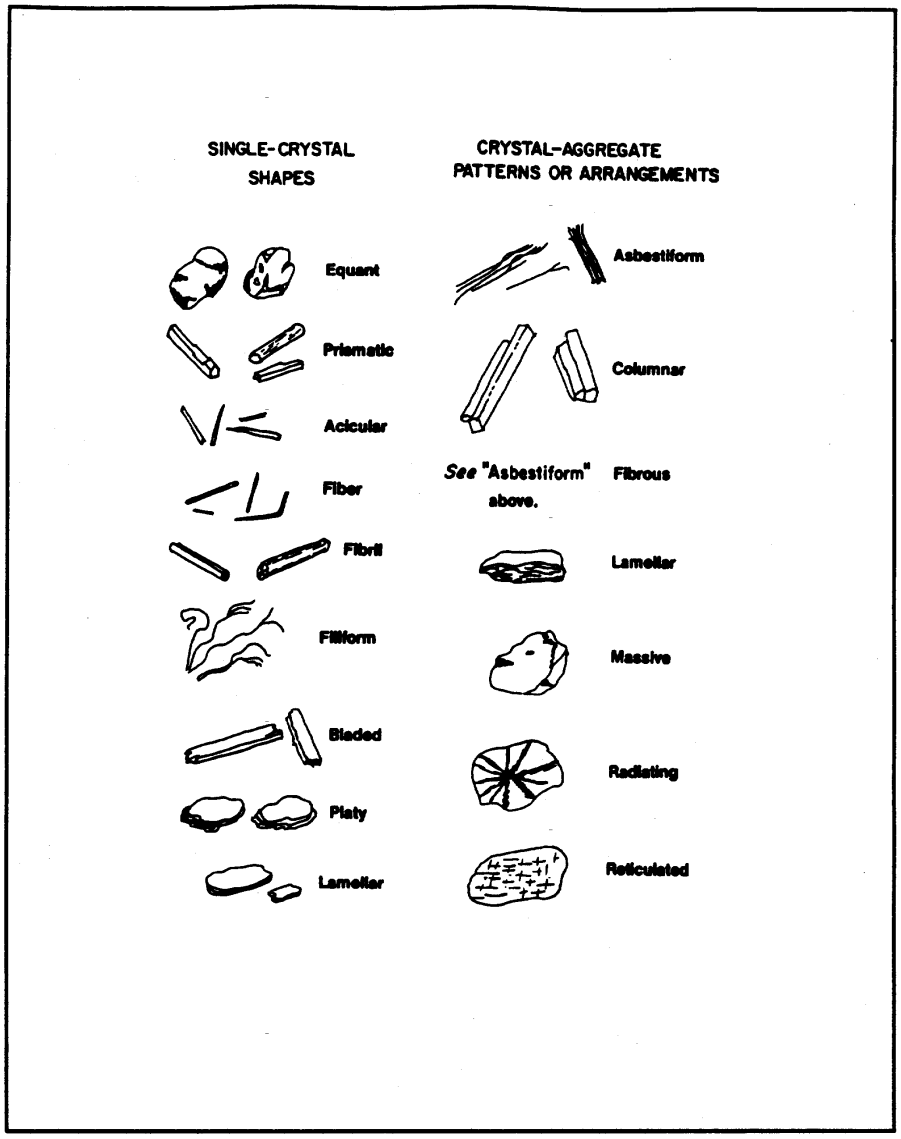

Figure 1. Particle definitions showing mineral growth habits. From the U.S. Bureau of Mines

For the purpose of regulation, the mineral must be one of the six minerals covered and must be in the asbestos growth habit. Large specimen samples of asbestos generally have the gross appearance of wood. Fibers are easily parted from it. Asbestos fibers are very long compared with their widths. The fibers

have a very high tensile strength as demonstrated by bending without breaking. Asbestos fibers exist in bundles that are easily parted, show longitudinal fine structure and may be tufted at the ends showing ''bundle of sticks'' morphology. In the microscope some of these properties may not be observable. Amphiboles do not always show striations along their length even when they are asbestos. Neither will they always show tufting. They generally do not show a curved nature except for very long fibers. Asbestos and asbestiform minerals are usually characterized in groups by extremely high aspect ratios (greater than 100:1). While aspect ratio analysis is useful for characterizing populations of fibers, it cannot be used to identify individual fibers of intermediate to short aspect ratio. Observation of many fibers is often necessary to determine whether a sample consists of ''cleavage fragments'' or of asbestos fibers.

Most cleavage fragments of the asbestos minerals are easily distinguishable from true asbestos fibers. This is because true cleavage fragments usually have larger diameters than 1 μ m. Internal structure of particles larger than this usually shows them to have no internal fibrillar structure. In addition, cleavage fragments of the monoclinic amphiboles show inclined extinction under crossed polars with no compensator. Asbestos fibers usually show extinction at zero degrees or ambiguous extinction if any at all. Morphologically, the larger cleavage fragments are obvious by their blunt or stepped ends showing prismatic habit. Also, they tend to be acicular rather than filiform.

Where the particles are less than 1 μ m in diameter and have an aspect ratio greater than or equal to 3:1, it is recommended that the sample be analyzed by SEM or TEM if there is any question whether the fibers are cleavage fragments or asbestiform particles.

Care must be taken when analyzing by electron microscopy because the interferences are different from those in light microscopy and may structurally be very similar to asbestos. The classic interference is between anthophyllite and biopyribole or intermediate fiber. Use the same morphological clues for electron microscopy as are used for light microscopy, e.g. fibril splitting, internal longitudinal striation, fraying, curvature, etc.

(1) Gross examination:

Examine the sample, preferably in the glass vial. Determine the presence of any obvious fibrous component. Estimate a percentage based on previous experience and current observation. Determine whether any pre-preparation is necessary. Determine the number of phases present. This step may be carried out or augmented by observation at 6 to 40× under a stereo microscope.

(2) After performing any necessary pre-preparation, prepare slides of each phase as described above. Two preparations of the same phase in the same index medium can be made side-by-side on the same glass for convenience. Examine with the polarizing stereo microscope. Estimate the percentage of asbestos based on the amount of birefringent fiber present.

(3) Examine the slides on the phase-polar microscopes at magnifications of 160 and 400×. Note the morphology of the fibers. Long, thin, very straight fibers with little curvature are indicative of fibers from the amphibole family. Curved, wavy fibers are usually indicative of chrysotile. Estimate the percentage of asbestos on the phase-polar microscope under conditions of crossed polars and a gypsum plate. Fibers smaller than 1.0 μ m in thickness must be identified by inference to the presence of larger, identifiable fibers and morphology. If no larger fibers are visible, electron microscopy should be performed. At this point, only a tentative identification can be made. Full identification must be made with dispersion microscopy. Details of the tests are included in the appendices.

(4) Once fibers have been determined to be present, they must be identified. Adjust the microscope for dispersion mode and observe the fibers. The microscope has a rotating stage, one polarizing element, and a system for generating dark-field dispersion microscopy (see Section 4.6. of this appendix). Align a fiber with its length parallel to the polarizer and note the color of the Becke lines. Rotate the stage to bring the fiber length perpendicular to the polarizer and note the color. Repeat this process for every fiber or fiber bundle examined. The colors must be consistent with the colors generated by standard asbestos reference materials for a positive identification. In n=1.550, amphiboles will generally show a yellow to straw-yellow color indicating that the fiber indices of refraction are higher than the liquid. If long, thin fibers are noted and the colors are yellow, prepare further slides as above in the suggested matching liquids listed below:

Type of asbestos	Index of refraction
Chrysotile	n=1.550.
Amosite	n=1.670 r 1.680.
Crocidolite	n=1.690.
Anthophyllite	n=1.605 nd 1.620.
Tremolite	n=1.605 and 1.620.
Actinolite	n=1.620.

Where more than one liquid is suggested, the first is preferred; however, in some cases this liquid will not give good dispersion color. Take care to avoid interferences in the other liquid; e.g., wollastonite in n=1.620 will give the same colors as tremolite. In n=1.605 wollastonite will appear yellow in all directions. Wollastonite may be determined under crossed polars as it will change from blue to

yellow as it is rotated along its fiber axis by tapping on the cover slip. Asbestos minerals will not change in this way.

Determination of the angle of extinction may, when present, aid in the determination of anthophyllite from tremolite. True asbestos fibers usually have 0° extinction or ambiguous extinction, while cleavage fragments have more definite extinction.

Continue analysis until both preparations have been examined and all present species of asbestos are identified. If there are no fibers present, or there is less than 0.1% present, end the analysis with the minimum number of slides (2).

(5) Some fibers have a coating on them which makes dispersion microscopy very difficult or impossible. Becke line analysis or electron microscopy may be performed in those cases. Determine the percentage by light microscopy. TEM analysis tends to overestimate the actual percentage present.

(6) Percentage determination is an estimate of occluded area, tempered by gross observation. Gross observation information is used to make sure that the high magnification microscopy does not greatly over- or under-estimate the amount of fiber present. This part of the analysis requires a great deal of experience. Satisfactory models for asbestos content analysis have not yet been developed, although some models based on metallurgical grain-size determination have found some utility. Estimation is more easily handled in situations where the grain sizes visible at about 160× are about the same and the sample is relatively homogeneous.

View all of the area under the cover slip to make the percentage determination. View the fields while moving the stage, paying attention to the clumps of material. These are not usually the best areas to perform dispersion microscopy because of the interference from other materials. But, they are the areas most likely to represent the accurate percentage in the sample. Small amounts of asbestos require slower scanning and more frequent analysis of individual fields.

Report the area occluded by asbestos as the concentration. This estimate does not generally take into consideration the difference in density of the different species present in the sample. For most samples this is adequate. Simulation studies with similar materials must be carried out to apply microvisual estimation for that purpose and is beyond the scope of this procedure.

(7) Where successive concentrations have been made by chemical or physical means, the amount reported is the percentage of the material in the ''as submitted'' or original state. The percentage determined by microscopy is multiplied by the fractions remaining after pre-preparation steps to give the percentage in the original sample. For example:

Step 1. 60% remains after heating at 550 °C for 1 h.

Step 2. 30% of the residue of step 1 remains after dissolution of carbonate in 0.1 m HCl.

Step 3. Microvisual estimation determines that 5% of the sample is chrysotile asbestos.

The reported result is:

R = (Microvisual result in percent)×(Fraction remaining after step 2)×(Fraction remaining of original sample after step 1)

R = (5)×(.30)×(.60) = 0.9%

(8) Report the percent and type of asbestos present. For samples where asbestos was identified, but is less than 1.0%, report ''Asbestos present, less than 1.0%.'' There must have been at least two observed fibers or fiber bundles in the two preparations to be reported as present. For samples where asbestos was not seen, report as ''None Detected.''

4. Auxiliary Information

Because of the subjective nature of asbestos analysis, certain concepts and procedures need to be discussed in more depth. This information will help the analyst understand why some of the procedures are carried out the way they are.

4.1. Light

Light is electromagnetic energy. It travels from its source in packets called quanta. It is instructive to consider light as a plane wave. The light has a direction of travel. Perpendicular to this and mutually perpendicular to each other, are two vector components. One is the magnetic vector and the other is the electric vector. We shall only be concerned with the electric vector. In this description, the interaction of the vector and the mineral will describe all the observable phenomena. From a light source such a microscope illuminator, light travels in all different direction from the filament.

In any given direction away from the filament, the electric vector is perpendicular to the direction of travel of a light ray. While perpendicular, its orientation is random about the travel axis. If the electric vectors from all the light rays were lined up by passing the light through a filter that would only let light rays with electric vectors oriented in one direction pass, the light would then be *POLARIZED*.

Polarized light interacts with matter in the direction of the electric vector. This is the polarization direction. Using this property it is possible to use polarized light to probe different materials and identify them by how they interact with light. The speed of light in a vacuum is a constant at about 2.99×10^{8} m/s. When light travels in different materials such as air, water, minerals or oil, it does not travel at this speed. It travels slower. This slowing is a function of both the

material through which the light is traveling and the wavelength or frequency of the light. In general, the more dense the material, the slower the light travels. Also, generally, the higher the frequency, the slower the light will travel. The ratio of the speed of light in a vacuum to that in a material is called the index of refraction (n). It is usually measured at 589 nm (the sodium D line). If white light (light containing all the visible wavelengths) travels through a material, rays of longer wavelengths will travel faster than those of shorter wavelengths, this separation is called dispersion. Dispersion is used as an identifier of materials as described in Section 4.6.

4.2. Material Properties

Materials are either amorphous or crystalline. The difference between these two descriptions depends on the positions of the atoms in them. The atoms in amorphous materials are randomly arranged with no long range order. An example of an amorphous material is glass. The atoms in crystalline materials, on the other hand, are in regular arrays and have long range order. Most of the atoms can be found in highly predictable locations. Examples of crystalline material are salt, gold, and the asbestos minerals.

It is beyond the scope of this method to describe the different types of crystalline materials that can be found, or the full description of the classes into which they can fall. However, some general crystallography is provided below to give a foundation to the procedures described.

With the exception of anthophyllite, all the asbestos minerals belong to the monoclinic crystal type. The unit cell is the basic repeating unit of the crystal and for monoclinic crystals can be described as having three unequal sides, two 90° angles and one angle not equal to 90°. The orthorhombic group, of which anthophyllite is a member has three unequal sides and three 90° angles. The unequal sides are a consequence of the complexity of fitting the different atoms into the unit cell. Although the atoms are in a regular array, that array is not symmetrical in all directions. There is long range order in the three major directions of the crystal. However, the order is different in each of the three directions. This has the effect that the index of refraction is different in each of the three directions. Using polarized light, we can investigate the index of refraction in each of the directions and identify the mineral or material under investigation. The indices α, β, and γ are used to identify the lowest, middle, and highest index of refraction respectively. The x direction, associated with α is called the fast axis. Conversely, the z direction is associated with γ and is the slow direction. Crocidolite has α along the fiber length making it ''length-fast''. The remainder of the asbestos minerals have the γ axis along the fiber length. They are called ''length-slow''. This orientation to fiber length is used to aid in the identification of asbestos.

4.3. Polarized Light Technique

Polarized light microscopy as described in this section uses the phase-polar microscope described in Section 3.2. A phase contrast microscope is fitted with two polarizing elements, one below and one above the sample. The polarizers have their polarization directions at right angles to each other. Depending on the tests performed, there may be a compensator between these two polarizing elements. Light emerging from a polarizing element has its electric vector pointing in the polarization direction of the element. The light will not be subsequently transmitted through a second element set at a right angle to the first element. Unless the light is altered as it passes from one element to the other, there is no transmission of light.

4.4. Angle of Extinction

Crystals which have different crystal regularity in two or three main directions are said to be anisotropic. They have a different index of refraction in each of the main directions. When such a crystal is inserted between the crossed polars, the field of view is no longer dark but shows the crystal in color. The color depends on the properties of the crystal. The light acts as if it travels through the crystal along the optical axes. If a crystal optical axis were lined up along one of the polarizing directions (either the polarizer or the analyzer) the light would appear to travel only in that direction, and it would blink out or go dark. The difference in degrees between the fiber direction and the angle at which it blinks out is called the angle of extinction. When this angle can be measured, it is useful in identifying the mineral. The procedure for measuring the angle of extinction is to first identify the polarization direction in the microscope. A commercial alignment slide can be used to establish the polarization directions or use anthophyllite or another suitable mineral. This mineral has a zero degree angle of extinction and will go dark to extinction as it aligns with the polarization directions. When a fiber of anthophyllite has gone to extinction, align the eyepiece reticle or graticule with the fiber so that there is a visual cue as to the direction of polarization in the field of view. Tape or otherwise secure the eyepiece in this position so it will not shift.

After the polarization direction has been identified in the field of view, move the particle of interest to the center of the field of

view and align it with the polarization direction. For fibers, align the fiber along this direction. Note the angular reading of the rotating stage. Looking at the particle, rotate the stage until the fiber goes dark or ''blinks out''. Again note the reading of the stage. The difference in the first reading and the second is an angle of extinction.

The angle measured may vary as the orientation of the fiber changes about its long axis. Tables of mineralogical data usually report the maximum angle of extinction. Asbestos forming minerals, when they exhibit an angle of extinction, usually do show an angle of extinction close to the reported maximum, or as appropriate depending on the substitution chemistry.

4.5. Crossed Polars With Compensator

When the optical axes of a crystal are not lined up along one of the polarizing directions (either the polarizer or the analyzer) part of the light travels along one axis and part travels along the other visible axis. This is characteristic of birefringent materials.

The color depends on the difference of the two visible indices of refraction and the thickness of the crystal. The maximum difference available is the difference between the α and the γ axes. This maximum difference is usually tabulated as the birefringence of the crystal.

For this test, align the fiber at 45° to the polarization directions in order to maximize the contribution to each of the optical axes. The colors seen are called retardation colors. They arise from the recombination of light which has traveled through the two separate directions of the crystal. One of the rays is retarded behind the other since the light in that direction travels slower. On recombination, some of the colors which make up white light are enhanced by constructive interference and some are suppressed by destructive interference. The result is a color dependent on the difference between the indices and the thickness of the crystal. The proper colors, thicknesses, and retardations are shown on a Michel-Levy chart. The three items, retardation, thickness and birefringence are related by the following relationship:

$R = t(n_{\gamma—\alpha})$

R = retardation, t = crystal thickness in μ m, and

$_{\alpha,\gamma}$ = indices of refraction.

Examination of the equation for asbestos minerals reveals that the visible colors for almost all common asbestos minerals and fiber sizes are shades of gray and black. The eye is relatively poor at discriminating different shades of gray. It is very good at discriminating different colors. In order to compensate for the low retardation, a compensator is added to the light train between the polarization elements. The compensator used for this test is a gypsum plate of known thickness and birefringence. Such a compensator when oriented at 45° to the polarizer direction, provides a retardation of 530 nm of the 530 nm wavelength color. This enhances the red color and gives the background a characteristic red to red-magenta color. If this ''full-wave'' compensator is in place when the asbestos preparation is inserted into the light train, the colors seen on the fibers are quite different. Gypsum, like asbestos has a fast axis and a slow axis. When a fiber is aligned with its fast axis in the same direction as the fast axis of the gypsum plate, the ray vibrating in the slow direction is retarded by both the asbestos and the gypsum. This results in a higher retardation than would be present for either of the two minerals. The color seen is a second order blue. When the fiber is rotated 90° using the rotating stage, the slow direction of the fiber is now aligned with the fast direction of the gypsum and the fast direction of the fiber is aligned with the slow direction of the gypsum. Thus, one ray vibrates faster in the fast direction of the gypsum, and slower in the slow direction of the fiber; the other ray will vibrate slower in the slow direction of the gypsum and faster in the fast direction of the fiber. In this case, the effect is subtractive and the color seen is a first order yellow. As long as the fiber thickness does not add appreciably to the color, the same basic colors will be seen for all asbestos types except crocidolite. In crocidolite the colors will be weaker, may be in the opposite directions, and will be altered by the blue absorption color natural to crocidolite. Hundreds of other materials will give the same colors as asbestos, and therefore, this test is not definitive for asbestos. The test is useful in discriminating against fiberglass or other amorphous fibers such as some synthetic fibers. Certain synthetic fibers will show retardation colors different than asbestos; however, there are some forms of polyethylene and aramid which will show morphology and retardation colors similar to asbestos minerals. This test must be supplemented with a positive identification test when birefringent fibers are present which can not be excluded by morphology. This test is relatively ineffective for use on fibers less than 1 μ m in diameter. For positive confirmation TEM or SEM should be used if no larger bundles or fibers are visible.

4.6. Dispersion Staining

Dispersion microscopy or dispersion staining is the method of choice for the identification of asbestos in bulk materials. Becke line analysis is used by some laboratories and yields the same results as does dispersion staining for asbestos and can be used in lieu of dispersion staining. Dispersion staining is performed on the same platform as the

phase-polar analysis with the analyzer and compensator removed. One polarizing element remains to define the direction of the light so that the different indices of refraction of the fibers may be separately determined. Dispersion microscopy is a dark-field technique when used for asbestos. Particles are imaged with scattered light. Light which is unscattered is blocked from reaching the eye either by the back field image mask in a McCrone objective or a back field image mask in the phase condenser. The most convenient method is to use the rotating phase condenser to move an oversized phase ring into place. The ideal size for this ring is for the central disk to be just larger than the objective entry aperture as viewed in the back focal plane. The larger the disk, the less scattered light reaches the eye. This will have the effect of diminishing the intensity of dispersion color and will shift the actual color seen. The colors seen vary even on microscopes from the same manufacturer. This is due to the different bands of wavelength exclusion by different mask sizes. The mask may either reside in the condenser or in the objective back focal plane. It is imperative that the analyst determine by experimentation with asbestos standards what the appropriate colors should be for each asbestos type. The colors depend also on the temperature of the preparation and the exact chemistry of the asbestos. Therefore, some slight differences from the standards should be allowed. This is not a serious problem for commercial asbestos uses. This technique is used for identification of the indices of refraction for fibers by recognition of color. There is no direct numerical readout of the index of refraction. Correlation of color to actual index of refraction is possible by referral to published conversion tables. This is not necessary for the analysis of asbestos. Recognition of appropriate colors along with the proper morphology are deemed sufficient to identify the commercial asbestos minerals. Other techniques including SEM, TEM, and XRD may be required to provide additional information in order to identify other types of asbestos.

Make a preparation in the suspected matching high dispersion oil, e.g., n=1.550 for chrysotile. Perform the preliminary tests to determine whether the fibers are birefringent or not. Take note of the morphological character. Wavy fibers are indicative of chrysotile while long, straight, thin, frayed fibers are indicative of amphibole asbestos. This can aid in the selection of the appropriate matching oil. The microscope is set up and the polarization direction is noted as in Section 4.4. Align a fiber with the polarization direction. Note the color. This is the color parallel to the polarizer. Then rotate the fiber rotating the stage 90° so that the polarization direction is across the fiber. This is the perpendicular position. Again note the color. Both colors must be consistent with standard asbestos minerals in the correct direction for a positive identification of asbestos. If only one of the colors is correct while the other is not, the identification is not positive. If the colors in both directions are bluish-white, the analyst has chosen a matching index oil which is higher than the correct matching oil, e.g. the analyst has used n = 1.620 where chrysotile is present. The next lower oil (Section 3.5.) should be used to prepare another specimen. If the color in both directions is yellow-white to straw-yellow-white, this indicates that the index of the oil is lower than the index of the fiber, e.g. the preparation is in n = 1.550 while anthophyllite is present. Select the next higher oil (Section 3.5.) and prepare another slide. Continue in this fashion until a positive identification of all asbestos species present has been made or all possible asbestos species have been ruled out by negative results in this test. Certain plant fibers can have similar dispersion colors as asbestos. Take care to note and evaluate the morphology of the fibers or remove the plant fibers in pre-preparation. Coating material on the fibers such as carbonate or vinyl may destroy the dispersion color. Usually, there will be some outcropping of fiber which will show the colors sufficient for identification. When this is not the case, treat the sample as described in Section 3.3. and then perform dispersion staining. Some samples will yield to Becke line analysis if they are coated or electron microscopy can be used for identification.

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APPENDIX L TO § 1915.1001—WORK PRACTICES AND ENGINEERING CONTROLS FOR AUTOMOTIVE BRAKE AND CLUTCH INSPECTION, DISASSEMBLY, REPAIR AND ASSEMBLY—MANDATORY

This mandatory appendix specifies engineering controls and work practices that must be implemented by the employer during automotive brake and clutch inspection, disassembly, repair, and assembly operations. Proper use of these engineering controls and work practices by trained employees will reduce employees' asbestos exposure below the permissible exposure level during clutch and brake inspection, disassembly, repair, and assembly operations. The employer shall institute engineering controls and work practices using either the method set forth in paragraph [A] or paragraph [B] of this appendix, or any other method which the employer can demonstrate to be equivalent in terms of reducing employee exposure to asbestos as defined and which meets the requirements described in paragraph [C] of this appendix, for those facilities in which no more than 5 pairs of brakes or 5 clutches are inspected, disassembled, reassembled and/or repaired per week, the method set forth in paragraph [D] of this appendix may be used:

[A] Negative Pressure Enclosure/HEPA Vacuum System Method

(1) The brake and clutch inspection, disassembly, repair, and assembly operations shall be enclosed to cover and contain the clutch or brake assembly and to prevent the release of asbestos fibers into the worker's breathing zone.

(2) The enclosure shall be sealed tightly and thoroughly inspected for leaks before work begins on brake and clutch inspection, disassembly, repair, and assembly.

(3) The enclosure shall be such that the worker can clearly see the operation and shall provide impermeable sleeves through which the worker can handle the brake and clutch inspection, disassembly, repair and assembly. The integrity of the sleeves and ports shall be examined before work begins.

(4) A HEPA-filtered vacuum shall be employed to maintain the enclosure under negative pressure throughout the operation. Compressed-air may be used to remove asbestos fibers or particles from the enclosure.

(5) The HEPA vacuum shall be used first to loosen the asbestos containing residue from the brake and clutch parts and then to evacuate the loosened asbestos containing material from the enclosure and capture the material in the vacuum filter.

(6) The vacuum's filter, when full, shall be first wetted with a fine mist of water, then removed and placed immediately in an impermeable container, labeled according to paragraph (k)(8) of this section and disposed of according to paragraph (l) of this section.

(7) Any spills or releases of asbestos containing waste material from inside of the enclosure or vacuum hose or vacuum filter shall be immediately cleaned up and disposed of according to paragraph (l) of the section.

[B] Low Pressure/Wet Cleaning Method

(1) A catch basin shall be placed under the brake assembly, positioned to avoid splashes and spills.

(2) The reservoir shall contain water containing an organic solvent or wetting agent. The flow of liquid shall be controlled such that the brake assembly is gently flooded to

prevent the asbestos-containing brake dust from becoming airborne.

(3) The aqueous solution shall be allowed to flow between the brake drum and brake support before the drum is removed.

(4) After removing the brake drum, the wheel hub and back of the brake assembly shall be thoroughly wetted to suppress dust.

(5) The brake support plate, brake shoes and brake components used to attach the brake shoes shall be thoroughly washed before removing the old shoes.

(6) In systems using filters, the filters, when full, shall be first wetted with a fine mist of water, then removed and placed immediately in an impermeable container, labeled according to paragraph (k)(8) of this section and disposed of according to paragraph (l) of this section.

(7) Any spills of asbestos-containing aqueous solution or any asbestos-containing waste material shall be cleaned up immediately and disposed of according to paragraph (l) of this section.

(8) The use of dry brushing during low pressure/wet cleaning operations is prohibited.

[C] Equivalent Methods

An equivalent method is one which has sufficient written detail so that it can be reproduced and has been demonstrated that the exposures resulting from the equivalent method are equal to or less than the exposures which would result from the use of the method described in paragraph [A] of this appendix. For purposes of making this comparison, the employer shall assume that exposures resulting from the use of the method described in paragraph [A] of this appendix shall not exceed 0.016 f/cc, as measured by the OSHA reference method and as averaged over at least 18 personal samples.

[D] Wet Method

(1) A spray bottle, hose nozzle, or other implement capable of delivering a fine mist of water or amended water or other delivery system capable of delivering water at low pressure, shall be used to first thoroughly wet the brake and clutch parts. Brake and clutch components shall then be wiped clean with a cloth.

(2) The cloth shall be placed in an impermeable container, labelled according to paragraph (k)(8) of this section and then disposed of according to paragraph (l) of this section, or the cloth shall be laundered in a way to prevent the release of asbestos fibers in excess of 0.1 fiber per cubic centimeter of air.

(3) Any spills of solvent or any asbestos containing waste material shall be cleaned up immediately according to paragraph (l) of this section.

(4) The use of dry brushing during the wet method operations is prohibited.

[59 FR 41080, Aug. 10, 1994, as amended at 60 FR 33344, June 28, 1995; 60 FR 33987–33995, June 29, 1995; 60 FR 36044, July 13, 1995; 60 FR 50412, Sept. 29, 1995; 61 FR 43457, Aug. 23, 1996; 63 FR 35137, June 29, 1998]

§ 1915.1002 Coal tar pitch volatiles; interpretation of term.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1002 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1003 13 carcinogens (4–Nitrobiphenyl, etc.).

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1004 alpha-Naphthylamine.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1005 [Reserved]

§ 1915.1006 Methyl chloromethyl ether.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1007 3,3′-Dichlorobenzidiene (and its salts).

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1008 bis-Chloromethyl ether.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at § 1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1009 beta-Naphthylamine.

NOTE: The requirements applicable to shipyard employment under this section are

identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1010 Benzidine.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1011 4-Aminodiphenyl.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1012 Ethyleneimine.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1013 beta-Propiolactone.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1014 2-Acetylaminofluorene.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1015 4-Dimethylaminoazobenzene.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1016 N-Nitrosodimethylamine.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1003 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1017 Vinyl chloride.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1017 of this chapter.

[61 FR 31430, June 20, 1996]

§ 1915.1018 Inorganic arsenic.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1018 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1020 Access to employee exposure and medical records.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1020 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1025 Lead.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1025 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1027 Cadmium.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1027 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1028 Benzene.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1028 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1030 Bloodborne pathogens.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1030 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1044 1,2-dibromo-3-chloropropane.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1044 of this chapter.

[61 FR 31431, June 20, 1996]

§ 1915.1045 Acrylonitrile.

NOTE: The requirements applicable to shipyard employment under this section are

identical to those set forth at §1910.1045 of this chapter.

[61 FR 31431, June 20, 1996]

§1915.1047 Ethylene oxide.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1047 of this chapter.

[61 FR 31431, June 20, 1996]

§1915.1048 Formaldehyde.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1048 of this chapter.

[61 FR 31431, June 20, 1996]

§1915.1050 Methylenedianiline.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1050 of this chapter.

[61 FR 31431, June 20, 1996]

§1915.1052 Methylene chloride.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at 29 CFR 1910.1052.

[62 FR 1619, Jan. 10, 1997]

§1915.1200 Hazard communication.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1200 of this chapter.

[61 FR 31431, June 20, 1996]

§1915.1450 Occupational exposure to hazardous chemicals in laboratories.

NOTE: The requirements applicable to shipyard employment under this section are identical to those set forth at §1910.1450 of this chapter.

[61 FR 31431, June 20, 1996]

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