WV-0191 #153

PLAINTIFF'S EXHIBIT

UC-2296

UNION CARBIDE CORPORATION

SPECIALTY CHEMICALS DIVISION

SOUTH CHARLESTON PLANT

HAZARD COMMUNICATION PROGRAM

UNION CARBIDE

UCC 002302

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CHEMICAL HAZARDS
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HEALTH AND PHYSICAL HAZARDS

CARCINOGENS

A CARCINOGEN IS ANY SUBSTANCE THAT CAUSES THE DEVELOPMENT OF CANCEROUS GROWTHS IN LIVING TISSUE. SUCH SUBSTANCES ARE GROUPED INTO TWO CLASSIFICATIONS:

(A) COMPOUNDS THAT ARE KNOWN TO INDUCE CANCER IN MAN OR ANIMALS EITHER BY EXPOSURE IN INDUSTRY OR BY INGESTION IN FEEDSTUFFS.

EXAMPLES:

1. ASBESTOS
2. ACRYLONITRILE

(B) EXPERIMENTAL CARCINOGENS THAT HAVE BEEN FOUND TO CAUSE CANCER IN ANIMALS UNDER EXPERIMENTAL CONDITIONS.

RECOMMENDED SAFETY EQUIPMENT:

WHEN HANDLING CARCINOGENS, A WEIGHMASTER SHOULD BE PROPERLY EQUIPPED TO INSURE VIRTUALLY NO CONTACT WITH THE CARCINOGEN. THE EQUIPMENT SHOULD INCLUDE HARD HAT, SAFETY GLASSES, RUBBER GLOVES, RAIN SUIT(JACKET, PANTS, BOOTS/OVERSHOES), SELF CONTAINED BREATHING APPARATUS WITH FULL FACE PIECE.

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SOUTH CHARLESTON PLANT

HAZARD COMMUNICATION PROGRAM

Copy Number Twenty-seven (27)

Issued to: JK CORRIE

Location: Bldg 46 Loc 514

NOTE: If this manual changes hands or is moved to another location, notify the 514 Safety/Health Department, x-2128 or x-2209.

UCC 002304

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Policy Statement

It is the policy of the South Charleston Plant to comply in full with the provisions of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

In accordance with the Standard, this Hazard Communication Program will be made available, upon request, to affected employees, their designated representatives, and to the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

Hazard Communication Program

Section I - Introduction

(A) Purpose of Program

The purpose of the Hazard Communication Program is to:

(1) ensure that the hazards of chemicals present at the South Charleston Plant are evaluated and that information concerning such hazards is transmitted to affected employees,

(2) comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200), and

(3) reduce the likelihood of employees experiencing illnesses or injuries related to exposure to hazardous chemicals present in their work area. (See Section III for definition of hazardous chemical.)

(B) Scope and Application

(1) The Hazard Communication Program applies to all South Charleston Plant departments whose employees may be exposed to hazardous chemicals under normal operating conditions or foreseeable emergencies. Office workers, security personnel and non-resident employees are generally not included unless their job tasks routinely involve potential exposures to hazardous chemicals. (For definition of "foreseeable emergency" refer to page 53341 of the OSHA Standard.)

(2) The program applies to all hazardous chemicals (including bulk commercial quantities of consumer products, such as paints, antifreeze, brake fluid, etc., which meet the definition for hazardous) known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency. (See exception (3)(a)(iv).)

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(3) The program provides for partial and total exclusions.

(a) Partial exclusion. Chemicals exempt from the labeling requirement include:

(i) pesticides subject to the labeling requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA);

(ii) food, food additives, color additives, drugs or cosmetics subject to the labeling requirements of the Federal Food, Drug and Cosmetic Act (FFDCA);

(iii) distilled spirits, wine or malt beverage intended for non-industrial use when subject to labeling requirements of the Federal Alcohol Administrative Act or the Bureau of Alcohol, Tobacco and Firearms; and

(iv) any consumer product subject to a consumer product safety standard, or the labeling requirement of the Consumer Product Safety Act (CPSA), or regulations issued by the Consumer Product Safety Commission.

(b) Total exclusion. Chemicals totally excluded from coverage of the Program include:

(i) hazardous wastes subject to regulation by the solid waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (RCRA);

(ii) tobacco and tobacco products;

(iii) wood or wood products;

(iv) articles;* and

(v) foods, drugs or cosmetics intended for personal use by employees while in the workplace.

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* "Article" means a manufactured item which (1) is formed to a specific shape or design during manufacture; (2) has end use function(s) dependent in whole or in part upon its shape or design during end use; and (3) does not release, or otherwise result in exposure to a hazardous chemical under normal conditions of use.

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Section II - Responsibilities

(A) South Charleston Plant Responsibilities

The Plant Industrial Hygienist is the Plant Hazard Communication Program coordinator for the South Charleston Plant. The Plant coordinator will:

(1) provide the written Hazard Communication Program for the South Charleston Plant to the operating, maintenance, distribution, and laboratory, etc. departments. The Plant coordinator will ensure the South Charleston Plant program contains all mandatory elements of OSHA 1910.1200;

(2) maintain an evergreen master list of hazardous chemicals present at the South Charleston Plant;

(3) maintain a master file of material safety data sheets (or equivalents) for all hazardous materials present at the South Charleston Plant;

(4) assist in evaluating chemicals for physical and health hazards;

(5) periodically audit site compliance with the requirements of the OSHA Hazard Communication Standard; and

(6) coordinate inplant distribution of updated material safety data sheets and/or appropriate new hazardous chemical information that becomes available.

B) Department Responsibilities

Department Supervision for each operating, maintenance, distribution, and laboratory departments will designate a Hazard Communication Program Coordinator and provide the name of the coordinator to the Plant HC Program Coordinator. The department coordinators will:

(1) aid in identifying and evaluating chemicals present, including intermediates, in their work areas for physical and health hazards;

(2) provide the Plant HC Program Coordinator with lists of all hazardous chemicals present in their work areas;

(3) ensure material safety data sheets, or their equivalent, are available for all hazardous chemicals (including intermediates) present in their work areas and made accessible to all employees who produce, use, handle or otherwise are potentially exposed to the substances;

(4) provide the Plant HC Program Coordinator with a copy of all available material safety data sheets, or their equivalent; as necessary

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(5) ensure required warning labels are affixed to containers of hazardous chemicals in accordance with the Hazard Communication Standard requirements;

(6) ensure through formal training that all affected employees are aware of the hazards of the chemicals present in their work areas and that such training is documented;

(7) maintain evergreen their department's lists of hazardous chemicals and library of material safety data sheets (or equivalents).

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Section III - Hazard Determination

(A) Scope

A hazard determination must be made for all chemical substances known to be present in the work area. Substances immediately specified as being hazardous are those listed in:

(1) OSHA Toxic and Hazardous Substances list (29 CFR 1910, Subpart Z),

(2) Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment - ACGIH TLV (latest edition),

(3) The Annual Report on Carcinogens published by the National Toxicology Program (NTP) - latest edition, and

(4) The International Agency for Research on Cancer (IARC) Monographs (latest edition).

A composite of the substances referenced above is located in the section of this manual entitled "Substances List".

Appendixes A and B of the OSHA Hazard Communication Standard are mandatory for making a hazard determination for a particular chemical substance. Appendix C is optional; however, it references information sources available for use in making the determinations required by Appendixes A and B.

A hazard determination logic has been established utilizing the definitions of "hazardous" provided in the OSHA Hazard Communication Standard. This logic will be used for determining physical and health hazards of chemicals for which there are no material safety data sheets or equivalents (such as UCC Chemical Data Sheets or Experimental Product Safety Data Sheets). The hazard determination logic is set forth in Attachment III-A, Hazard Determination Criteria, and Attachment III-B, Worksheet for Hazard Determination, of this Section.

(B) Physical and Health Hazard Determination

(1) Review work area list of chemicals to determine if any are exempt from being designated as hazardous. Refer to Section I paragraph (B)(3)(b) of this manual for exemptions.

(2) Use Attachment III-A of this Section for hazard determination:

(a) identify all chemical substances which are deemed hazardous by virtue of containing 1% or more (by weight or volume) of a substance referenced by:

(i) OSHA Subpart Z, Toxic and Hazardous Substances,

(ii) ACGIH TLV list.

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(b) identify all chemical substances considered to be carcinogenic by virtue of the fact they contain 0.1% or more (by weight or volume) of a material listed as a carcinogen or potential carcinogen by OSHA, NTP or IARC (refer to Substances Lists):

(c) review remaining chemical substances for hazard following the logic established in the Hazard Determination Criteria.

NOTE: If a chemical component is present in a mixture at a concentration less than 1% (or in the case of carcinogens, less than 0.1%), but could be released in airborne concentrations in excess of the OSHA permissible exposure limit or the ACGIH Threshold Limit Value, or could present a health hazard to employees at those concentrations, the mixture shall be considered to present the same hazard.

(C) Upon request, the Industrial Hygiene Department will provide assistance in making hazard determinations. The requester should complete lines A through F of Attachment III-B and submit it to the Industrial Hygiene supervisor for the hazard determination.

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ATTACHMENT III-A

HAZARD DETERMINATION CRITERIA

The following guideline criteria is used for determining physical and health hazards of chemicals at the South Charleston Plant.

Hazard Evaluation Procedure

Hazard Determination Criteria(All Components 1% or Greater - All Questions, Mixture Test Data, If Available, All Questions)

Question 1. Is the Material listed in
a) 29 CFR 1910 Subpart Z, or
b) ACGIH (Latest)

This material is established as hazardous and the hazard must be evaluated using the criteria in question 2-20.

Code L0 or L1

Criteria: The chemical manufacturer, importer, or employer evaluating chemicals shall treat the following sources as establishing that the chemicals listed in them are hazardous:

(i) 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), L0; or,

(ii) Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, American Conference of Governmental Industrial Hygienists, L1

the chemical manufacturer, importer, or employer is still responsible for evaluating the hazards associated with the chemicals in these source lists in accordance with the requirements of the standard.

Question 2. Is the material carcinogenic?

Use this criteria for all components of concentrations of .1% or more by weight.

Code L2, L3, or L4

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Criteria: Carcinogen: A chemical is considered to be a carcinogen if:

a) It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen L2; or

b) It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program(NTP) (latest edition), L3; or

c) It is regulated by OSHA as a carcinogen, L4.

Question 3. Is the material teratogenic?

Code H0

Criteria: A chemical is considered to be a teratogen if listed by UCC on the Internal Exposure Standards List (IESL).

Question 4 Is the material corrosive?

Code H1

Criteria: Corrosive: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U. S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

Question 5. Is the material highly toxic?

Code: H2

Criteria: Highly Toxic: A chemical falling within any of the following catergories:

a) A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when adminis- tered orally to albino rats weighing between 200 and 300 grams each.

b) A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

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c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Question 6 Is the material an irritant?

Code: H3

Criteria: Irritant: A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

Question 7 Is the material a sensitizer?

Code H4

Criteria: Sensitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Question 8 Is the material toxic?

Code H5

Criteria: Toxic: A chemical falling within any of the following categories:

a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

b) A chemical that a median lethal does (LC_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

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c. A chemical that has a medium lethal concentration (LC_{50}) in air of more that 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Question 9. Does the material demonstrate target organ effects?

Code H6

Criteria: Target Organ Effects: The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but are not intended to be all-inclusive.

a) Hepatoxins -- Chemicals which produce liver damage.

Signs and Symptoms -- Jaundice; Liver Enlargement

Chemicals -- Carbon tetrachloride; nitrosamines.

b) Nephrotoxins -- Chemicals which produce kidney damage.

Signs and Symptoms -- Edema; proteinuria.

Chemicals -- Halogenated hydrocarbons; uranium.

c) Neurotoxins -- Chemicals which produce their primary toxic effects on the nervous system.
Signs and Symptoms -- Narcosis; behavioral changes; decrease in motor functions.
Chemicals -- Mercury; carbon disulfide.

d) Agents which act on the blood or hematopoietic system -- Decrease hemoglobin function; deprive the body tissues of oxygen.

Signs and Symptoms -- Cyanosis; loss of consciousness.

Chemicals -- Carbon monoxide; cyanides.

e) Agents which damage the lung -- Chemicals which irritate or damage the pulmonary tissue.
Signs and Symptoms -- Cough; tightness in chest, shortness of breath.
Chemicals -- Silica; asbestos.

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f) Reproductive toxins -- Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Signs and Symptoms -- Birth defects; sterility.

Chemicals -- Lead; DBCP.

g) Cutaneous Hazards -- Chemicals which affect the dermal layer of body.

Signs and Symptoms -- Defatting of the skin; rashes, irritation.

Chemicals -- Ketones, Chlorinated compounds.

h) Eye hazards -- Chemicals which affect the eye or visual capacity.

Signs and Symptoms -- Conjuctivitis; corneal damage.

Chemicals -- Organic solvents; acids.

Question 10 Are there any other known health hazards significant enough to include?

Code H7

Criteria: Adequacy and Reporting of Data: The results of any studies which are designed and conducted according to established scientific principles, and which report statistically significant conclusions regarding the health effects of a chemical, shall be a sufficient basis for a hazard determination and reported on any material safety data sheet. The chemical manufacturer, importer, or employer may also report the results of other scientifically valid studies which tend to refute the findings of hazard.

Question 11 Is the material a compressed gas?

Code P0

Criteria: "Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°); or

(iii) A liquid having a vapor pressure exceeding 40 psig at 100 degrees Fahrenheit (37.8°C) as determined by ASTM D-323-72.

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Question 12 Is the material an explosive?

Code P1

Criteria: "Explosive" means a chemical that causes a sudden almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Question 13 Is the material flammable?

Code P2

Criteria: "Flammable" means a chemical that falls into one of the following categories:

(i) "Aerosol flammable" means an aerosol that when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

(ii) "Gas flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume, regardless of the lower limit.

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit.

(iii) "Liquid, flammable" means any liquid having a closed cup flash point below 100°F (37.8°C), except any mixture having components with flash points of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 18 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Question 14 Is the material a combustible liquid?

Code P3

Criteria: "Combustible liquid" means any liquid having a closed cup flash point at or above 100°F (38.8°C), but below 200°F (93.3°C), except any mixture having components with flash points of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

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Question 15 Is the material an organic peroxide?

Code P4

Criteria: "Organic peroxide" means an organic compound that contains the bivalent -O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Question 16 Is the material an oxidizer?

Code P5

Criteria: "Oxidizer" means a chemical, other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Question 17 Is the material pyrophoric?

Code P6

Criteria: "Pyrophoric" means a chemical that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below.

Question 18 Is the material unstable (reactive)?

Code P7

Criteria: "Unstable (reactive)" means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will be come self-reactive under conditions of shocks, pressure or temperature.

Question 19 Is the material water-reactive?

Code P8

Criteria: "Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Question 20 Are there any other known physical hazards significant enough to include?

Code P9

Criteria: Adequacy and Reporting of Data: The results of any studies which are designed and conducted according to established scientific principles, and which report statistically significant conclusions regarding the physical effects of a chemical shall be a sufficient basis for a hazard determination and reported on any material safety data sheet. The chemical manufacturer, importer, or employer may also report the results of other scientifically valid studies which tend to refute the findings of hazard.

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ATTACHMENT III-B

SCD DIVISION--WORKSHEET FOR HAZARD DETERMINATION A. LOCATION _____
B. DEPARTMENT _____

C. Product:
Class Number: D. Trade Secret:
Hazard Code:

E. Chemical Identities and Percentages (1-5): _____

Components:	1	2	3	4	5	CODE
1 - Listed in 29 CFR 1910 Z or ACGIH						LO-1
2 - Carcinogenic						L2-4
3 - Teratogenic						HO
4 - Corrosive						H1
5 - Highly Toxic						H2
6 - Irritant						H3
7 - Sensitizer						H4
8 - Toxic						H5
9 - Target Organs						H6
10 - Other Health Hazards						H7
11 - Compressed Gas						PO
12 - Explosive						P1
13 - Flammable Material						P2
14 - Combustible Liquid						P3
15 - Organic Peroxide						P4
16 - Oxidizer						P5
17 - Pyrophoric						P6
18 - Unstable (Reactive)						P7
19 - Water Reactive Material						P8
20 - Other Physical Hazards						P9

F. SUBMITTED BY: _____ DATE: _____

EVALUATED BY: _____ DATE: _____

UCC 002319

Section IV - Chemical List

The Plant Hazard Communication Program Coordinator maintains a list of all hazardous materials known to be present at the South Charleston Plant.

The department Hazard Communication Program coordinators maintain a list of all hazardous materials known to be present in their work areas and the location(s) in the work area where they are found. The department Coordinators provide the Plant Coordinator with a copy of their hazardous chemicals lists.

The work area listings of chemicals, mandated hazard information, process labels and container labels are maintained readily and logically cross-referenced to each other. Common terms (names) for the chemicals are used and listed or cross-referenced to minimize confusion.

Employees are informed of the location and availability of the list(s) of hazardous chemicals present in their work areas.

The hazardous chemicals lists are reviewed at least annually and revised if necessary. New chemicals introduced into the work area are included on the lists at the time of introduction. Chemicals used on a "trial" basis for a limited time period need not be included on the chemical lists. However, affected employees must be informed of any potential hazards associated with the trial chemicals and a MSDS, or an equivalent, must be available before use.

For the purpose of the Hazard Communication Program, "chemical" is defined as raw materials, intermediates, crude products, final products, maintenance solvents, catalysts, cleaning solutions, paints, non-RCRA residue streams, etc. which meet the definition of hazardous chemical.

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Section V - Material Safety Data Sheets or Equivalent Protocol

A Centralized MSDS (or equivalent) document file is maintained at the Safety and Health Department by the location HCS Coordinator. Every reasonable effort is made to keep the MSDS (or equivalent) inventory current by:

1. Maintaining a liaison with the person responsible for maintaining the hazard communication document reference libraries in specific functional work areas at the location as regards the data base.

2. Maintaining a liaison with appropriate Purchasing Groups to ensure procurement of MSDS's for new (to the location) chemicals and access to revised MSDS's provided by vendors.

   NOTE: The includes monitoring for effective implementation of the location New Chemical Introduction Policy/Procedure 2.18.

3. Periodic reviews of the centralized data base hazardous chemical listing versus the listings in specific location functional work areas.

MSDS (or equivalent) document data bases (files, notebooks, etc.) are maintained in alphabetized form, according to the usual nomenclature for the chemical in use, in the specific functional work areas where the materials are stored, processed or otherwise handled. MSDS's (or equivalent) will contain the following information about the hazardous chemical and be written in legible English:

1. The identity that is used on the label of containers of the hazardous substance and except where protected as a trade secret:

   a. If single chemical, the chemical/common name.

   b. If mixture which has been tested, the chemical/common name of components which contribute to the hazard and common name of the mixture.

   c. If mixture has not been tested, the chemical/common name of components present at concentrations of greater than one percent which have been determined to be health hazards. The cut-off percentage is 0.1 percent for carcinogens.

2. Data/information for all ingredients in the mixture which have been determined to present a hazard:

   a. Physical/chemical characteristics of the hazardous chemical (vapor pressures; flash point).

   b. Physical hazards of the hazardous chemical (potential for fire, explosion, reactivity).

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c. The health hazards of the hazardous chemical (signs/symptoms of exposure; medical conditions generally recognized as being aggravated by exposure).

d. Primary route of exposure.

e. OSHA/ACGIH/other exposure limit used.

f. Whether hazardous chemical is listed in NTP or OSHA Carcinogen Report, or IARC as a carcinogen.

3. Safe handling/use precautions (protective measures; spill/leak, clean-up).

4. Control measures (engineering controls, work practices; protective personal equipment).

5. Emergency/first aid procedures.

6. Date of MSDS preparation.

7. The name/address/phone of chemical manufacturer/importer/employer or responsible party preparing/distributing MSDS who can provide additional information.

NOTE: There will be occasions where complex mixtures or families of compounds having similar composition and hazard will be covered by a single MSDS (or equivalent).

The Department Head of the functional area maintaining the work-place hazard communication document library (or data base) is responsible to ensure that MSDS's or equivalents are obtained and maintained for all chemicals designated as hazardous within that functional area. The Department Head shall provide the Industrial Hygiene Department with a copy of the MSDS (or equivalent) for any hazardous chemical new to the South Charleston Plant that is to be introduced into their workplace.

MSDS's (or equivalents) are maintained readily accessible to employees during each work shift. MSDS's (or equivalents) are also available, upon request, to designated employee representatives and to OSHA and NIOSH.

If a hazardous chemical supplier (internal or internal to UCC) fails to provide an MSDS with the initial shipment, documented initiatives are made via the Purchasing function to obtain the MSDS's.

Whenever a hazardous substance is supplied from more than one vendor or source, only one MSDS is maintained, usually the one determined to most accurately reflect the nature and hazards of the chemical substance. MSDS's determined to be obsolete or superseded are removed from the MSDS (or equivalent) document libraries (data bases).

NOTE: In some cases it may be advisable to maintain copies of each vendors MSDS in a separate filing system.

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The hazard communication document libraries (data bases) at the South Charleston Plant are kept in an updated and current form. When new and significant hazard information becomes known, the appropriate libraries (data bases) are updated with the new information as soon as is practical.

It is the responsibility of the chemical manufacturer or importer to evaluate the hazards of the chemicals they produce or import and prepare material safety data sheets (MSDS's) for such chemicals. The Specialty Chemicals Division of UCC will provide an MSDS for all chemical substances manufactured or imported by the division in accordance with the provisions of 29 CFR 1910.1200(g). Provision of MSDS's for hazardous chemicals, including intermediates, produced by other UCC divisions will be the responsibility of the division that has the business accountability for that substance.

MSDS's need not be retained for any specific period of time, except to the extent required by the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.20). This standard states that MSDS's need not be retained for any specific period as long as some record of the identity of the hazardous substance, where it was used and when it was used is retained for at least 30 years. A copy of 29CFR 1910.20 is located in the HC Program Notebook.

Upon request, the Industrial Hygiene Department will provide assistance in obtaining MSDS's. To request such assistance, complete the REQUEST FOR MATERIAL SAFETY DATA SHEETS form, included at the end of this section, and return it to the Industrial Hygiene supervisor.

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Section VI - Labeling

(A) Scope and Application

A label is any written, printed or graphic material displayed or affixed to a container of hazardous chemicals. Its purpose is to provide immediate visual warning, to provide a link to the detailed information in a MSDS and to serve as a visual reminder of information presented to employees in training programs.

"Container" means any bag, barrel, bottle, box, can, cylinder , drum, reaction vessel, storage tank, etc. that contains a hazardous chemical. Pipes and piping systems are not considered to be containers.

Label information must not conflict with the requirements of the Hazardous Materials Transportation Act issued by the Department of Transportation.

The OSHA Hazard Communication Standard labeling requirements exempt pesticides subject to labeling requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Environmental Protection Agency. Other labeling exemptions are noted in section (b)(4) of the Standard. If the hazardous chemical is regulated by an OSHA substance specific health standard, the label must be in compliance with the requirement of that standard.

(B) General

1. Labeling hazard warning mechanisms are provided for stationary and portable containers in the workplace as required under 29 CFR 1910.1200 which:

    a. Are in legible English, where appropriate.

    b. Identify the hazardous chemical(s) contained and are traceable to more detailed material safety data (e.g. MSDS's) provided.

    c. Provide appropriate hazard warnings. Hazard warnings may be in written form, or in readily identifiable codes that will alert workers (trained in code recognition) to the hazard and encourage them to refer to the more detailed hazard information in the workplace safety data base.

    d. Are prominently displayed or readily available and accessible.

    e. Are in accord with OSHA labeling requirements specific to OSHA health standards, when applicable.

2. Labels on incoming containers of hazardous chemical are not removed or defaced unless the container is immediately marked with required information.

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(C) Stationary Containers

1. Each stationary container of hazardous chemical(s) in a given work area is marked or identified in such a manner as to allow it to be cross-referenced back to hazard communication documentation (MSDS's etc.) in the work area which is specific to the chemicals being contained. The cross-referencing mechanisms generally used are one or more of the following:

   - o Container labels specifying the chemical(s) contained
   - o Container numbering
   - o System flow diagrams that are process/product oriented
   - o Batch ticket/run sheets/log sheets
   - o Standard Operating Procedures
   - o Inventory logs
   - o Control panel marking/labeling
   - o Signs
   - o Hazard or hazard code markings
   - o Placards/Tags

Common location terminology for the contained chemical(s) (similar to that on MSDS's) is used to facilitate accessing hazard communication documentation. As an example of how this cross-referencing mechanism can work:

a. The component equipment and piping in batch kettle system XYZ is marked/labeled with individual alphanumeric designations.

b. The log sheets at the control panel for kettle system XYZ are marked to indicate that chemical ABC is being produced.

c. The Standard Operating Procedures (or alternatively a system flow diagram developed to depict the typical contained chemical prevalence pattern through the system) specific to the production of ABC in system XYZ are available in the workplace and identify the hazardous chemicals of concern by the nomenclature typically used for them at the location and used on the chemical hazard documentation located in the workplace.

d. Chemical hazard documentation fulfilling the requirements of 29 CFR 1910.1200(g) for MSDS or equivalents is provided in an accessible form (notebooks, file drawers, etc.) at an accessible location in the given work area for all chemicals in the work area designated as hazardous facilitating worker access to information on the chemical hazards of chemical ABC.

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2. The department head for the functional area that the stationary containers reside in is responsible to ensure that:

   a. Appropriate labeling/hazard warning mechanisms are maintained for the stationary containers. (See Appendix to this section for labeling specifics.)

   b. Reviews are conducted and labeling/hazard warning mechanisms are maintained in an up-to-date and operational condition.

(D) Unlabeled Equipment - Process Systems

Some individual pieces of process equipment (pumps, strainers, piping, etc.) in process systems that are not considered containers under the standard may be labeled and some not. Whenever no visible markings exist, employees have access to flow diagrams, operating instructions, batch tickets, processing procedures, postings, charts, placards, etc., cross-referenced to the necessary and available health and safety information (MSDS's etc.).

(E) Portable Containers - In Plant

1. Each portable container of hazardous chemical(s) is marked or identified in a manner which provides warning of the specific hazards involved and facilitates referencing hazard communication documentation in the workplace that is specific to the chemical(s) contained. The marking/identifying mechanisms used are generally one or more of the following:

   - Container labels specifying the chemical(s) contained - may be undefaced external manufacturer/importer labels which meet the provisions of 29 CFR 1910.1200 and may be supplemented with location labels according to South Charleston Plant practice. (See Appendix to this section for labeling specifics.)
   - Container numbering
   - Signs
   - Stenciled or taped on markings
   - Placards and/or tags
   - Hazard or hazard code markings
   - Inventory log sheets
   - Service/status log sheets

   Labeling, marking or identification is done in a fashion that facilitates accessing of hazard communication documentation using common location terminology for the contained chemical(s) - identical to that on MSDS's. As an example of how the specific hazard information specific to a hazardous chemical under the standard can be referenced:

   a. A tank wagon trailer (No. XYZ) contains chemical ABC.

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b. The trailer is provided with placards and/or tags at appropriate locations which indicate that chemical ABC is contained and indicates the principal hazards of ABC (in written out form or in a code recognizable/interpretable to affected employees). (Alternatively, or supplemental to the above, inventory or service/status log sheets may be kept which reference Trailer XYZ by number and indicate that is currently contains chemical ABC.)

c. Chemical hazard documentation fulfilling the requirements of 29 CFR 1910.1200(g) for MSDS or equivalents in provided in an accessible form at an accessible location in the given work area for all chemicals being handled, processed, or contained within it designated as hazardous facilitating worker access to information on the chemical hazards of chemical ABC.

NOTE: One option for fulfilling the requirement for worker access to hazard communication documentation is to post a copy of an MSDS (or the equivalent) for chemical ABC with the portable container.

2. The department head(s) for the functional area(s) that has (have) accountability for the personnel that load/move/gauge/unload or otherwise work with the trailer are responsible, within their functional areas, to ensure that:

a. Appropriate labeling/hazard warning mechanisms are maintained for the portable containers.

b. Reviews are conducted and labeling/hazard warning mechanisms are maintained in an up-to-date and operational condition.

NOTE: EXCEPTION - There is no requirement to label portable containers into which hazardous chemicals are transferred when the contents are to be used and/or appropriately disposed of by the employee performing the transfer during his or her work shift.

(F) Portable Containers - Ex Plant

1. Portable containers of hazardous materials leaving the plant (location) are marked with the following information:

a. Identity of the hazard chemical(s) - idnetical to that on MSDS's.

b. Appropriate hazard warnings

c. Name and address of manufacturer, importer or other responsible party

in a fashion which does not conflict with requirements of the Hazardous Materials Transportation Act (HMTA) and regulations issued under that act by the Department of Transportation (DOT). (Refer to appropriate distribution function manuals for specifics.)

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2. Shipment of portable containers from the plant (locations are in accord with applicable HMTA provisions and DOT regulations.

3. The Distribution Area Department (or equivalent) for the plant (location) is responsible to ensure compliance with statements VI.E.1 and VI.E.2.

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Section VII - Trade Secrets

The OSHA Hazard Communication Standard (HCS) provides for the protection of trade secrets. Specialty Chemicals Division of UCC will protect its proprietary business information and in accordance with applicable provisions in the OSHA HCS whenever necessary and appropriate. The SCD HS&EA Manager for Product Safety and Liability and/or Product Safety Manager should be consulted on trade secret issues involving the division's products.

Conditions for withholding a trade secret identity from an MSDS are:

(1) the claim of trade secrecy must be supportable,

(2) all information concerning the properties and effects of the chemical must be disclosed on the MSDS,

(3) the MSDS indicates that the specific chemical identity is being withheld as a trade secret, and

(4) the specific identity is made available to health professionals under specific circumstances.

The requirements for disclosure of a trade secret chemical identity in an emergency situation are:

When a treating physician or nurse determines a medical emergency exists and chemical identity is necessary for treatment, the chemical identity shall be immediately disclosed without first requiring a written statement of need or confidentiality agreement. The needs statement and confidentiality agreement can be requested later as soon as circumstances permit.

The requirements for disclosure of a trade secret chemical identity in a non-emergency situation are:

(1) the health professional requesting such information must be providing medical or other occupational health services to exposed employees,

(2) alternatively, the request must be from employee(s) themselves or a duly authorized representative of the employee(s).

(3) the request must be in writing,

(4) the writing must adequately describe a legitimate need for the information,

(5) must disclose why other information (other than chemical identity) cannot satisfy the need,

(6) a description of the procedures that will be used to maintain the confidentiality of the information, and

(7) the health professional, employee(s), or duly authorized representative of the employee(s) agree to sign a confidentiality agreement.

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Section VIII - Information and Training

(A) Department management is responsible for providing employees in their work area with information and training in accordance with the Hazard Communication Standard. Support is provided by the South Charleston Plant Training and Industrial Hygiene Departments. Training programs include the use of audio visuals, classroom instruction and field instruction. Employee information and training includes at least the following:

(1) Information. Employees are informed of:

(a) The requirements of the OSHA Hazard Communication Standard;

(b) Any operations in their work area where hazardous chemicals are present; and

(c) The location and availability of the department's written Hazard Communication Program, including the required list of hazardous chemicals and material safety data sheets.

(2) Training. Employee training includes as a minimum:

(a) Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as results of employee exposure monitoring performed by the Industrial Hygiene Department, continuous air monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(b) The physical and health hazards of the chemicals in the work area;

(c) The measures employees can take to protect themselves from these hazards, including specific procedures the South Charleston Plant has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, administrative controls, emergency procedures, and the specification of personal protective equipment to be used; and

(d) The details of the facility's Hazard Communication Program including an explanation of the Plant hazard signal index system (See attachments to this section) and the material safety data sheets, and how employees can obtain and use the appropriate hazard information.

(B) Training is provided:

(1) before May 25, 1986, where applicable,

(2) at the time of the employee's initial assignment to a work area,

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(3) whenever a new hazard is introduced into the work area, and

(4) whenever new data becomes available related to the hazards associated with an existing chemical present in the work area.

(C) Employees are provided with information and training on the chemical hazards in their work area. The following are minimum guidelines and can be expanded or enhanced at the discretion of department management:

(1) Employees who are assigned to work in a specific unit or area of the Plant are trained on the chemical hazards specific to that unit or area. For example:

(a) Employees assigned to the Solvent Vinyl Resins Unit need to be trained only on the hazardous chemicals associated with that Unit.

(b) Distribution employees permanently assigned to a specific work area need to be trained only on the chemical hazards associated with that area.

(2) Employees who are assigned to a work area, but work in a specific unit most of the time, are trained on the chemical hazards associated with both areas. For example, maintenance employees assigned to Maintenance Area 2 and who normally work at the Polyols Unit most of time are trained on the chemical hazards associated with the Polyols Unit and any chemical hazards associated with the maintenance complex (e.g., maintenance, solvents, paints, welding/burning, etc.).

(3) Employees who are assigned to a department (e.g., maintenance, security, etc.) or work area, but have plant-wide work assignments, (e.g., maintenance shut-down work, overtime, etc.) are trained on the chemical hazards associated with the specific work task. They need not be trained on the chemical hazards of the entire plant. Specific hazard information can be communicated through existing Plant safety procedures and policies, by the area supervision or both. Documentation of this training is not required. For example:

(a) Maintenance employees temporarily assigned outside their normal work areas, such as for maintenance shutdown or for overtime jobs, need not be trained on all the chemical hazards associated with the work area in which they are temporarily assigned. Rather, employees are informed of the hazards associated with the specific task they are assigned to perform. This can be performed through the area supervision, Plant safety procedures or both.

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(b) Distribution employees normally assigned to a specific work area may be temporarily assigned to another location for overtime, vacation relief, etc. Such employees are trained on the chemical hazards associated with their normal work area and provided training on the specific chemical hazard which is present in the work area during their temporary job assignment.

(D) For those cases where the hazardous nature of a chemical has been defined in the MSDS, the hazards defined in the MSDS may be used and communicated to affected employees as part of the training program.

(E) Department management is responsible for ensuring employee training is effective. This can be done through written question and answer forms. observation for compliance with safe work practices, uses of safe work permits (e.g., Master Tag and Lock Procedures), proper use of personal protective equipment, etc.

(F) Except where otherwise noted, all information and training provided to employees must be documented and such documentation must be maintained for the duration of the employee's employment plus 30 years.

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HAZARD COMMUNICATION PROGRAM

REFERENCE MANUAL

UCC 002333

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PURPOSE

To alert employees to potentially hazardous chemicals and to inform them of the appropriate procedures required to handle them safely.

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H. C. P. PROVISIONS

HAZARD EVALUATION

- ALL CHEMICALS AND MIXTURES MUST BE EVALUATED FOR POTENTIAL HAZARDS.

WARNING LABELS

- WARNING LABELS MUST BE APPLIED TO CONTAINERS OF POTENTIALLY HAZARDOUS SUBSTANCES.

MATERIAL SAFETY DATA SHEETS

- MATERIAL SAFETY DATA SHEETS MUST BE COMPILED FOR EACH POTENTIALLY HAZARDOUS SUBSTANCE AND MAINTAINED WITHIN THE WORKPLACE.

SPECIFIC TRAINING

- EMPLOYEES MUST BE PROVIDED WITH INFORMATION AND TRAINING REGARDING THE POTENTIAL HAZARDS IN THEIR SPECIFIC WORK AREAS.

WRITTEN PROGRAM

- WRITTEN HAZARD COMMUNICATION PROGRAMS MUST BE DEVELOPED AND MADE AVAILABLE TO EMPLOYEES.

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EVALUATION

RESPONSIBILITY

THE PRIMARY RESPONSIBILITY FOR EVALUATING A CHEMICAL'S POTENTIALLY HARMFUL PHYSICAL OR HEALTH EFFECTS RESTS WITH THE CHEMICALS PRODUCER OR IMPORTER.

INVESTIGATION

CHEMICALS MAY BE EVALUATED FOR POTENTIAL HAZARDS BY THOROUGHLY INVESTIGATING ALL OF THE AVAILABLE SCIENTIFIC EVIDENCE.

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HEALTH HAZARDS

CARCINOGENS

A CANCER CAUSING AGENT AS DETERMINED BY EVALUATIONS DONE BY INDEPENDENT AGENCIES IDENTIFIED BY OSHA.

IRRITANTS

CHEMICALS WHICH CAUSE A REVERSIBLE, INFLAMMATORY EFFECT AT THE POINT OF CONTACT.

SENSITIZERS

CHEMICALS WHICH WILL CAUSE AN ALLERGIC REACTION IN A SUBSTANTIAL PERCENTAGE OF THE POPULATION.

CORROSIVES

CHEMICALS WHICH CAUSE IRREVERSIBLE DAMAGE TO SKIN OR TISSUE.

TOXIC

A CHEMICAL DETERMINED TO BE LETHAL THROUGH INGESTION, INHALATION OR ABSORPTION IN LABORATORY TEST ANIMALS.

HIGHLY TOXIC

CHEMICALS REQUIRING LOWER CONCENTRATIONS TO ACHIEVE TOXIC RESULTS.

TARGET ORGANS

CHEMICALS WHICH EFFECT SPECIFIC ORGANS AS OPPOSED TO THE WHOLE BODY.

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PHYSICAL HAZARDS

COMBUSTIBLE

A SUBSTANCE WITH A FLASH POINT EXCEEDING 100°F.

COMPRESSED GASES

A GAS OR MIXTURE OF GASES EXERTING PRESSURE WITHIN A CONTAINER.

EXPLOSIVES

SUDDEN RELEASE OF PRESSURE, GAS AND HEAT DUE TO SUDDEN SHOCK, PRESSURE OR HIGH TEMPERATURE.

FLAMMABLE SUBSTANCES

SUBSTANCES WITH A FLASH POINT BELOW 100°F.

ORGANIC PEROXIDES

SUBSTANCES WHICH ARE HIGHLY COMBUSTIBLE, FLAMMABLE, EXPLOSIVE OR UNSTABLE.

UNSTABLE SUBSTANCES

SUBSTANCES WHICH WILL VIGOROUSLY REACT TO SHOCK, TEMPERATURE OR PRESSURE.

WATER REACTIVE

SUBSTANCES WHICH REACT WITH WATER TO PRODUCE A GAS WHICH IS FLAMMABLE OR PRESENTS A HEALTH HAZARD.

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WARNING LABELS
POTENTIALLY HAZARDOUS CHEMICALS

RESPONSIBILITY

- THE PRODUCER OR IMPORTER MUST LABEL CONTAINERS WITH AN APPROPRIATE WARNING BEFORE THEY ARE TRANSPORTED TO AN END USER.

CONTENT

- THE WARNING LABEL MUST INCLUDE THE IDENTITY OF THE CHEMICAL, APPROPRIATE HAZARD WARNINGS AND THE NAME AND ADDRESS OF THE PRODUCER OR IMPORTER.

MATERIAL TRANSFER

- IF A HAZARDOUS CHEMICAL IS TRANSFERRED FROM ITS ORIGINAL CONTAINER TO ANOTHER CONTAINER THE NEW CONTAINER MUST BE MARKED, TAGGED OR LABELED WITH AN APPROPRIATE HAZARD WARNING.

ALTERNATE WARNINGS

- ALTERNATE FORMS OF WARNINGS MIGHT BE SIGNS, PROCESS SHEETS, OPERATING PROCEDURES AND OTHER WRITTEN MATERIALS FOR STATIONARY CONTAINERS.

LABEL IMPORTANCE

- ANY LABEL THAT IS ACCIDENTALLY DEFACED OR REMOVED SHOULD BE REPLACED IMMEDIATELY TO ASSURE CONTINUED SAFETY.

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Methyl CELLOSOLVE®

ETHYLENE GLYCOL MONOMETHYL ETHER

OCTOBER 1, 1984

WARNING!

FOR INDUSTRY USE ONLY
NOT FOR USE IN CONSUMER PRODUCTS

- HARMFUL IF INHALED OR ABSORBED THROUGH SKIN
- CAUSES EYE IRRITATION
- COMBUSTIBLE

Do not breathe vapor. Use with adequate ventilation.
Do not get in eyes, on skin, or on clothing. Accidental contact should be washed away immediately.
Keep away from heat and open flame. Keep container closed.

- IN LABORATORY ANIMAL STUDIES, BIRTH DEFECTS AND ADVERSE EFFECTS ON PREGNANCY HAVE BEEN OBSERVED.

FOR WOMEN OF CHILDBEARING POTENTIAL:
- Maximum personal exposure limit in air 2 ppm (8 hour time weighted average)
- Maximum 15 minute excursion level 5 ppm (no more than four such excursions daily with a minimum separation of one hour).
- Avoid all skin contact.

- IN LABORATORY ANIMALS PROLONGED AND REPEATED EXPOSURE HAS CAUSED DAMAGE TO MALE REPRODUCTIVE ORGANS.

FOR PERSONS OTHER THAN WOMEN OF CHILDBEARING POTENTIAL:
- Maximum personal exposure limit in air 10 ppm (8 hour time weighted average)
- Maximum 15 minute excursion level 25 ppm (no more than four such excursions daily with a minimum separation of one hour).
- Avoid all skin contact.

FIRST AID: If inhaled, remove to fresh air if not breathing, give artificial respiration. If breathing difficult, give oxygen. Call a physician.
In case of contact, for eyes, immediately flush with plenty of water for at least 15 minutes. Call a physician.
For skin, flush with water. Wash clothing before re-use.

FOR FIRE — Use water spray, carbon dioxide, dry chemical, or "alcohol-type" foam.

FOR SPILL — Flush with water or cover with absorbent. Prevent runoff. Collect and dispose. Observe government regulations.

ATTENTION! EMPTIED CONTAINER RETAINS VAPOR AND PRODUCT RESIDUE
- DO NOT CUT OR WELD ON OR NEAR THIS CONTAINER
- OBEY ALL LABEL WARNINGS ESPECIALLY DURING DRUM CLEANING
- DO NOT REUSE THIS DRUM OR REMOVE THE LABEL UNLESS THOROUGHLY CLEANED.

- BEFORE USING OR HANDLING THIS CHEMICAL, YOU MUST READ AND UNDERSTAND THE LATEST UNION CARBIDE MATERIAL SAFETY DATA SHEET F-43201.

UCC 840-1AC
MADE IN U.S.A.

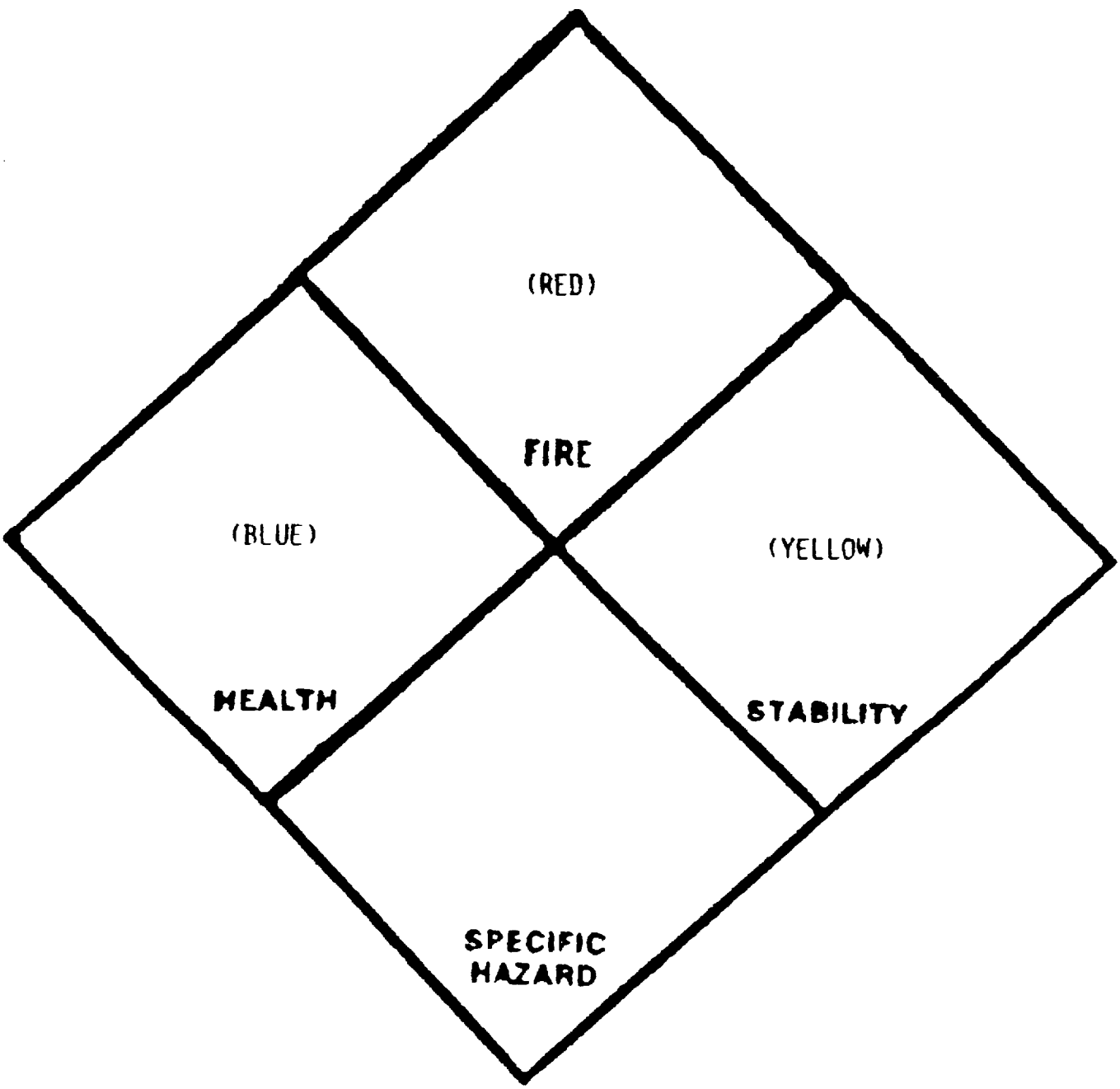
UCC 002340

UNION CARBIDE CORPORATION
SOLVENTS & COATING MATERIALS DIVISION
DANBURY, CT 06817 • OFFICES IN PRINCIPAL CITIES

IMO TECHNICAL NAME	UN NUMBER	PRODUCT CLASS	NET WEIGHT
ETHYLENE GLYCOL MONOMETHYL ETHER	1188	46825	202 kg 445 lb

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CHEMICAL HAZARD-SIGNAL SYSTEM



7-A

UCC 002341

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CHEMICAL HAZARD-SIGNAL SYSTEM: CLASSIFICATION DEFINITIONS

CLASSIFICATION BY TYPE OF HEALTH HAZARD[1]
(TOXICITY)
COLOR CODE: BLUE

SIGNAL	Type of Possible Injury
	Note: All materials are irritants or toxicants under certain conditions of use or exposure, therefore no material can be classified non-injurious to health.
	No residual injury is to be expected from accidental exposure, even if no treatment is applied.
	Minor residual injury may result from accidental exposure if no treatment is applied.
	Minor residual injury may result in spite of prompt treatment. Breathing equipment required to avoid exposure.
	Major residual injury may result in spite of prompt treatment. Breathing equipment required to avoid exposure.
	These materials are dangerous to life because of asphyxiation from lack of oxygen rather than toxic or narcotic effects.
	Materials which are cancer causing agents.

[1] These classifications for identification of materials by hazard are based on physical and chemical properties and do not include conditions of exposure handling. These conditions, therefore, must be considered in fully evaluating the hazard.

REFERENCE: Std. FP-210

UCC 002342

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CHEMICAL HAZARD-SIGNAL SYSTEM: CLASSIFICATION DEFINITIONS

CLASSIFICATION BY TYPE OF FIRE HAZARD[1]
(FLAMMABILITY)
COLOR CODE: RED

SIGNAL	Flash Point and Definition of Material
	No Flash Point - Materials that are non-combustible. (Green Signal)
	Above 140°F - Materials that must be heated before ignition can occur.
	Above 100°F through 140°F - Materials that must be heated or exposed to exceptionally high ambient temperature before ignition can occur.
	73°F through 100°F - Materials that can be ignited under normal ambient temperatures.
	Below 73°F (RVP below 14.7 psia) - Materials that can be ignited under almost all conditions. Below 73°F (RVP above 14.7 psia) - Materials that flash to vapor at atmospheric pressure and normal ambient temperature.

[1]These classifications for identification of materials by hazard are based on physical and chemical properties and do not include conditions of exposure handling. These conditions, therefore, must be considered in fully evaluating the hazard.

REFERENCE: Std. FP-210

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CHEMICAL HAZARD-SIGNAL SYSTEM: CLASSIFICATION DEFINITIONS

CLASSIFICATION BY TYPE OF STABILITY (REACTIVITY)
COLOR CODE: YELLOW

SIGNAL	Characteristics or Reaction of Material
	Note: All materials are reactive under certain conditions of use or exposure; therefore, no material can be classified as completely stable or non-reactive.
1	Normally stable materials.
2	Materials which are mildly reactive in the presence of contaminants or at elevated temperatures. (Heat of reaction will not raise temperature above the boiling point of the material.
3	Materials which are vigorously reactive in the presence of contaminants or which may become self-reactive at elevated temperatures. (Heat or reaction will raise temperatures above the boiling point of the material.)
4	Materials which can be detonated by shock, or which will detonate or explode by self-reaction under conditions of abnormal pressure, temperature, or concentration.
W	Materials which are reactive with water.

REFERENCE: Std. FP-210

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MATERIAL SAFETY DATA SHEETS (MSDS)

RESPONSIBILITY

- THE PRODUCER OR IMPORTER OF A POTENTIALLY HAZARDOUS CHEMICAL MUST SUPPLY A MATERIAL SAFETY DATA SHEET.

AVAILABILITY

- THE MSDS WILL BE KEPT ON FILE IN THE WORKPLACE AND WILL BE MADE AVAILABLE TO EMPLOYEES WHO WISH TO REVIEW THE INFORMATION.

SPECIFIC INFORMATION

- AN MSDS WILL INCLUDE SAFETY AND HEALTH DATA INCLUDING:

  1. ANY POTENTIAL HEALTH HAZARD ASSOCIATED WITH THE USE OR MISUSE OF THE SUBSTANCE.
  2. ANY PRECAUTIONS NECESSARY FOR USE, HANDLING, AND STORAGE.
  3. EMERGENCY PROCEDURES FOR LEAKS, SPILLS, FIRE, AND FIRST AID.
  4. SPECIFIC INFORMATION REGARDING THE PHYSICAL AND CHEMICAL PROPERTIES OF THE SUBSTANCE.

TRADE SECRETS

- SOME INFORMATION CAN BE LEGITIMATELY WITHHELD IF IT IS CONSIDERED A TRADE SECRET.

HEALTH EMERGENCY

- TRADE SECRET INFORMATION MUST BE RELEASED TO QUALIFIED HEALTH PROFESSIONALS IN CASE OF AN OCCUPATIONAL HEALTH EMERGENCY.

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MATERIAL SAFETY DATA SHEET

EFFECTIVE DATE: APRIL 1, 1985

Union Carbide Corporation urges the customer receiving this Material Safety Data Sheet to study it carefully to become aware of hazards, if any, of the product involved. In the interest of safety you should (1) notify your employees, agents, and contractors of the information on this sheet (2) furnish a copy to each of your customers for the product, and (3) request your customers to inform their employees and customers as well.

I. IDENTIFICATION

PRODUCT NAME:	BUTYL CELLOSOLVE®		
CHEMICAL NAME:	2-Butoxyethanol	CHEMICAL FAMILY:	Glycol Ethers
FORMULA:	$C_4H_9OC_2H_4OH$	MOLECULAR WEIGHT:	118.18
SYNONYMS:	Ethylene Glycol Monobutyl Ether		
DEPARTMENT OF TRANSPORTATION	Hazard Classification Shipping Name	Combustible liquid Combustible liquid, NOS	
CAS # 111-76-2	CAS NAME	Ethanol, 2-butoxy	

II. PHYSICAL DATA

BOILING POINT, 760 mm Hg	171.2°C (340.2°F)	FREEZING POINT	-70.4°C (-94.7° F)
SPECIFIC GRAVITY (H_2O = 1)	0.9022 at 20/20°C	VAPOR PRESSURE at 20°C	0.6 mm Hg
VAPOR DENSITY (air = 1)	4.1	SOLUBILITY IN WATER, % by wt.	Complete
PERCENT VOLATILES BY VOLUME	100	EVAPORATION RATE (Butyl Acetate = 1)	0.08
APPEARANCE AND ODOR	Colorless liquid; mild odor		

III. INGREDIENTS

MATERIAL	%	TLV	HAZARD
2-Butoxyethanol	100	25 ppm (skin) ACGIH 50 ppm (skin) OSHA	Toxic; Eye Irritant; Combustible

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	150°F, Tag Closed Cup, ASTM D 56; 157°F, Tag Open Cup, ASTM D 1310			
FLAMMABLE LIMITS IN AIR, % by volume	LOWER	1.1	UPPER	10.6
EXTINGUISHING MEDIA	Use water spray, carbon dioxide, dry chemical, alcohol-type, or universal-type foams applied by manufacturers' recommended techniques.			
SPECIAL FIRE FIGHTING PROCEDURES	Use self-contained breathing apparatus and protective clothing.			
UNUSUAL FIRE AND EXPLOSION HAZARDS	None			

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EMERGENCY PHONE NUMBER • 304/744-3487 • This number is available days, nights, weekends, and holidays.

UNION CARBIDE CORPORATION • SOLVENTS AND COATINGS MATERIALS DIVISION
OLD RIDGEBURY ROAD, DANBURY, CT 06817

V. HEALTH HAZARD DATA

TLV AND SOURCE:

25 ppm (skin) ACGIH, 1984-5
50 ppm (skin) OSHA 29 CFR, para. 1910.1000, Table Z-1

EFFECTS OF ACUTE OVEREXPOSURE

SWALLOWING	Moderately toxic. May cause headache, dizziness, incoordination, nausea, vomiting, diarrhea, and general weakness. Ingestion may cause red blood cell hemolysis and possible liver and kidney injury.
SKIN ABSORPTION	Penetrates skin readily. Frequent or widespread contact may result in the absorption of potentially harmful amounts. Signs and symptoms of toxicity are similar to those of swallowing.
INHALATION	High concentrations are irritating to the eyes and respiratory tract. May cause headache, dizziness, nausea, vomiting, and malaise.
SKIN CONTACT	Brief contact with undiluted material may cause slight reddening. More prolonged and widespread contact, as with chemical-saturated clothing, may cause moderate reddening, swelling, and possible damage to the skin.
EYE CONTACT	Causes moderate irritation and possible corneal injury.

EFFECTS OF REPEATED OVEREXPOSURE

Repeated overexposure may cause hemolysis of the red blood cells leading to possible liver and kidney damage.

OTHER HEALTH HAZARDS

Because of its irritating and defatting properties, this material may exacerbate an existing dermatitis.

EMERGENCY AND FIRST AID PROCEDURES:

SWALLOWING	Give two glasses of water and induce vomiting. Call a physician.
SKIN	Remove contaminated clothing and flush skin with water.
INHALATION	Remove to fresh air.
EYES	Immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention without delay.

NOTES TO PHYSICIAN
There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition.

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VI. REACTIVITY DATA

STABILITY			
UNSTABLE	STABLE	CONDITIONS TO AVOID	None
	X		

INCOMPATIBILITY (materials to avoid)	Avoid contamination with alkalies.
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS	Burning can produce carbon monoxide and/or carbon dioxide.

HAZARDOUS POLYMERIZATION			
May Occur	Will Not Occur	CONDITIONS TO AVOID	None
	X		

VII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	Wear suitable protective equipment. Small spills should be flushed with large quantities of water. Larger spills should be collected for disposal.
WASTE DISPOSAL METHOD	Incinerate in a furnace where permitted under appropriate Federal, State, and local regulations.

VIII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION	Self-contained breathing apparatus in high concentrations.
VENTILATION	This product should be handled in covered equipment, in which case general (mechanical) room ventilation is expected to be satisfactory. Special, local ventilation may be needed at points where vapors can be expected to escape to the workplace air.

PROTECTIVE GLOVES	Rubber	EYE PROTECTION	Monogoggles
OTHER PROTECTIVE EQUIPMENT	Eye bath and safety shower		

IX. SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid breathing vapor. Keep away from heat and flame. Avoid contact with eyes, skin, and clothing. Keep container closed. Use with adequate ventilation. Wash thoroughly after handling.

FOR INDUSTRY USE ONLY

OTHER PRECAUTIONS
Laboratory studies indicate that, at very low concentration in water, this product should be rapidly biodegraded in a biological wastewater treatment plant.

The opinions expressed here are those of qualified experts within Union Carbide Corporation. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and these opinions and the conditions of use of the product are not within the control of Union Carbide Corporation, it is the user's obligation to determine the conditions of safe use of the product.

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SPECIFIC TRAINING

THE FOLLOWING INFORMATION AND TRAINING MUST BE PROVIDED TO EMPLOYEES.

WORK AREA

- SPECIFIC INFORMATION AND TRAINING ON ANY OPERATIONS IN THE WORK AREA WHERE HAZARDOUS SUBSTANCES ARE PRESENT.

LOCATION OF WRITTEN MATERIALS

- THE LOCATION AND AVAILABILITY OF THE WRITTEN HAZARD COMMUNICATION PROGRAM, INCLUDING THE REQUIRED LISTS OF HAZARDOUS CHEMICALS KNOWN TO BE PRESENT IN THE WORKPLACE, AN EXPLANATION OF THE LABELING SYSTEM USED IN THE WORKPLACE, AND THE MATERIAL SAFETY DATA SHEETS.

DETECTION METHODS

- APPROPRIATE METHODS AND OBSERVATIONS THAT MAY BE USED TO DETECT THE PRESENCE OR RELEASE OF A HAZARDOUS CHEMICAL IN THE WORK PLACE.

CHEMICAL HAZARDS

- THE PHYSICAL AND HEALTH HAZARDS OF THE CHEMICALS IN THE WORK AREA.

PROTECTIVE MEASURES

- THE MEASURES EMPLOYEES CAN TAKE TO PROTECT THEMSELVES FROM CHEMICAL HAZARDS, INCLUDING APPROPRIATE WORK PRACTICES, EMERGENCY PROCEDURES, AND PERSONAL PROTECTIVE EQUIPMENT.

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The written program will describe HOW:

- **Materials are labeled**
- **MSDS's will be maintained**
- **Employees will be informed & trained**
- **Hazardous materials will be listed**
- **Special requirements will be satisfied**

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Section IX - Non-Routine Tasks

The South Charleston Plant will comply with existing divisional and Plant safety procedures to provide hazard information and protect employees against potential hazards associated with non-routine tasks and against hazardous chemicals contained in unlabeled pipes in their work area. (See Section VI. (D) for information transmittal specifics.)

In addition to the use of special sampling (e.g., monitoring for airborne contaminants), loading, unloading and other case specific handling techniques, one or more of the following procedures may be applicable:

(1) Master Tag and Lock Out (Procedure 2.5),

(2) Confined Space Entry (Procedure 2.4),

(3) Hazardous Work Permits (Procedure 2.3),

(4) Personal Protective Equipment (Procedure 2.21),

(5) Special procedures for handling hazardous substances

(6) Embryo-Fetal Protection Policy (Procedure 2.15),

(7) Department SOPs,

(8) Radiation Protection (Procedure 2.37),

The degree of training and information should be determined, in part, by the degree of risk associated with the work area or task. Those areas or tasks that handle or involve highly toxic or hazardous substances will require more specific information to be communicated to affected employees than those involving innocuous or low toxicity substances.

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Section X - Contractors

Interface with contractors is maintained in accordance with South Charleston Plant Contractor Procedures. Support is provided to Contractor supervision to ensure that contract employees are adequately informed, trained and warned of hazards they may be exposed to when working in the South Charleston Plant.

Whenever possible, the South Charleston Plant contract administrator is to inform the contractor management in writing of the potential hazards associated with the work to be performed by contract employees and make suggestions for appropriate protective measures to be taken by the contractor. General plant safety rules and procedures, and material safety data sheets, as applicable, will also be provided to the contractor. The contractor will be informed that it is their responsibility to ensure that their employees are adequately informed of and trained concerning the potential hazards associated with the work area in which they will be assigned.

Where it is not practical or feasible to furnish the contractor with the above information, suitable alternatives for informing contract employees of potential hazards must be developed. The plant contract administrator can inform contractors of the general plant safety rules and procedures. Unit supervision can provide information about potential hazards associated with the work area in which the contract employee is assigned. In some cases it may be adequate just to provide a general overview of the unit and any specific safety rules or requirements. At other times, specific information about the potential hazards associated with a work area or a work task will need to be provided. The degree of contractor training necessary will be determined, in part, by the degree of risk associated with the work area or task. Those areas or tasks that handle or involve highly toxic or hazardous substances will require more specific information than those that involve innocuous or low toxicity substances.

When contracts are administered by authorized personnel other than the contract administrator, the individual or department who is responsible for the contract will assume the contract administrator's role for dissemination of hazard information.

Forms, for contractor notification of responsibilities and of potential hazards, are located at the end of this section.

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UNION CARBIDE CORPORATION
SPECIALTY CHEMICALS DIVISION
SOUTH CHARLESTON PLANT

"CONTRACTOR NOTIFICATION OF POTENTIALLY HAZARDOUS CHEMICALS"

TO: _____

_____

_____

CONTRACT NUMBER: _____

Work Area(s) In Which Contract Work Will Be Performed: _____

In accordance with the South Charleston Plant Hazard Communication Program and its' policy to comply in full with the provisions of the OSHA Communication Standard 29CFR 1910.1200, we are herein advising you of potentially hazardous chemicals associated with the work area in which the "work" will be performed.

Your responsibility and obligation under this Federally mandated standard is to ensure that your employees who will be assigned this "work" are adequately informed, trained and warned prior to commencing work, about the potential hazards associated with the chemicals listed below. The appropriate Material Safety Data Sheets (MSDS's) are provided in order to assist you with this training effort.

CHEMICAL LIST

	CHEMICAL	MSDS ATTACHED YES	NO		CHEMICAL	MSDS ATTACHED YES	NO
1.	_____	☐	☐	6.	_____	☐	☐
2.	_____	☐	☐	7.	_____	☐	☐
3.	_____	☐	☐	8.	_____	☐	☐
4.	_____	☐	☐	9.	_____	☐	☐
5.	_____	☐	☐	10.	_____	☐	☐

Special Requirements/Precautions/Procedures

_____

_____

Any additional questions or concerns pertaining to the above requirements should be directed to the undersigned.

_____ _____

Name/Title/Telephone Signature

UCC 002354

UNION CARBIDE CORPORATION
SPECIALTY CHEMICALS DIVISION
SOUTH CHARLESTON PLANT

"CONTRACTOR NOTIFICATION OF THE SOUTH CHARLESTON PLANT CHEMICAL HAZARD SIGNAL AND TYPE CODE SYSTEM"

DATE: _____

TO: _____
_____
_____

The information contained herein is provided to assist you in training your employees to ensure that they are adequately informed, trained and warned about the potential hazards to which they may become exposed while performing work in the South Charleston Plant. Please note that is it your responsibility to ensure that this obligation has been fulfilled. This will include but, is not limited to an explanation of the South Charleston Plant Chemical Hazard Signal and Type Code System and the location of Material Safety Data Sheets (MSDS).

The "South Charleston Plant Chemical Hazard Signal and Type Code System" is an in-plant labeling identification system that provides an immediate visual reference to the identity of and potential risks associated with a specific chemical. The South Charleston Plant Chemical Hazard System (copy attached) includes classification for identification of materials by hazard based on physical and chemical properties with respect to Health (Toxicity) Color Code-Blue, Fire (Flammability) Color Code-Red and Stability (Reactivity) Color Code-Yellow. The degree of hazard is indicated with a numerical designation 1,2,3,4 in ascending order of severity. Specific Hazards (additional information), is provided when the material is known to present specific hazards such as carcinogens, asphyxiants or if the chemical is water reactive.

The Hazard Type Code (copy attached) following a chemical name consists of a letter and a number to identify whether the material is listed by a specific agency (L), poses a health hazard (H) or is a hazard because of its' physical properties (P). The combination of letter and digit designation in this system specifies what the actual hazard is; the numeric characters in this case DO NOT indicate the degree of severity of the hazard. (Pocket size cards are available which explain the South Charleston Plant Chemical Hazard Signal and Type Code System).

Additional information regarding precautions necessary for safe use, handling and storage; emergency procedures for leaks, spills, fire and first aid; and specific information on the physical and chemical properties of the material is contained in a document entitled Material Safety Data Sheets (MSDS). Upon request, MSDS's will be made available to your employees through the Contract Services Department, Industrial Hygiene Office, Shift Superintendent's Office or the actual unit where the potential hazard exists.

Any additional explanation or clarification of the "South Charleston Plant Chemical Hazard Signal and Type Code System" can be provided by the South Charleston Plant Contract Services Department.

Very truly yours,

_____

UCC 002355

SOUTH CHARLESTON PLANT

CHEMICAL HAZARD WARNING LABEL



CHEMICAL(S): _____

CHEMICAL HAZARD SIGNAL SYSTEM CLASSIFICATION DEFINITIONS

HEALTH	FIRE	REACTIVITY
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4

Hazard Type Code

L0 - Listed in OSHA 29CFR 1910.1000 Subpart Z.	H2 - Highly toxic
L1 - Listed in ACGIH Threshold Limit Value Document	H3 - Irritant
L2 - Listed as possible or known carcinogen by the International Agency for Research on cancer (IARC)	H4 - Sensitizer
L3 - Listed as a possible or known carcinogen on the most recent edition National Toxicology Program (NTP).	H5 - Toxic
L4 - Listed as a Carcinogen by OSHA.	H6 - Target Organs
H0 - Teratogen	H7 - Other health hazards
H1 - Corrosive	P0 - Compressed Gas
	P1 - Explosive
	P2 - Flammable
	P3 - Combustible
	P4 - Organic Peroxide
	P5 - Oxidizer
	P6 - Pyrophoric
	P7 - Unstable/Reactive
	P8 - Water Reactive
	P9 - Other Physical Hazard

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Section XI - Laboratories

The OSHA Hazard Communication Standard applies to South Charleston Plant laboratories as follows:

(1) Labels on incoming containers of hazardous chemicals are not removed or defaced;

(2) MSDS's received with incoming shipments of hazardous chemicals are be maintained and made readily available to employees;

(3) Laboratory employees are informed of the hazards of the chemicals in their work area and must be provided information and training as outlined in Section VIII, Information and Training, of this program, and

(4) Containers of hazardous chemicals (regardless of quantity) transported into and outside the laboratory must be labeled in accordance with Sections VI.D and VI.E of this program.

The Laboratory Department Head is accountable for ensuring that the stipulations above are maintained in a state of compliance.

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XII - AUDITS

Periodic audits (internal and external) commissioned by UCC, SCD, Location and Departmental managements are utilized to ensure that the foregoing provisions of the South Charleston Plant written Hazard Communication Program are maintained in a state of compliance.

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section 15 of the Act and Agency procedures.

(l) *Effective dates.* The effective dates of the final standard are structured according to activity; that is, information being sent downstream must be prepared first, then other provisions of the hazard communication program are to be complied with by a later date. Chemical manufacturers and importers have two years in which to comply with the labeling of containers shipped downstream, and to provide material safety data sheets to manufacturing purchasers. Distributors must also begin transferring information downstream by this initial compliance date. All employers must be in compliance with all provisions of the standard within 2½ years.

V. Authority, Signature and the Standard

This document was prepared under the direction of Thorne G. Auchter, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Avenue, N.W., Washington, D.C. 20210. Pursuant to Sections 8(b) and 8(g) of the Act, 29 CFR is hereby amended by adding a new § 1910.1200 to read as set forth below.

List of Subjects in 29 CFR Part 1910

Occupational safety and health, Hazard communication.

(Sec. 8(b), 8(c), and 8(g), Pub. L. 91-596, 84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657; 29 CFR Part 1911, Secretary of Labor's Order No. 9-83 (48 FR 35736))

Signed at Washington, D.C. this 21st day of November 1983.

Thorne G. Auchter,

Assistant Secretary for Occupational Safety and Health

PART 1910—[AMENDED]

Subpart Z of Part 1910 of Title 29 of the Code of Federal Regulations (CFR) is hereby amended by adding a new § 1910.1200 to read as follows:

§ 1910.1200 Hazard communication.

(a) *Purpose.* (1) The purpose of this section is to ensure that the hazards of all chemicals produced or imported by chemical manufacturers or importers are evaluated, and that information concerning their hazards is transmitted to affected employers and employees within the manufacturing sector. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

(2) This occupational safety and health standard is intended to address comprehensively the issue of evaluating and communicating chemical hazards to employees in the manufacturing sector, and to preempt any state law pertaining to this subject. Any state which desires to assume responsibility in this area may only do so under the provisions of § 18 of the Occupational Safety and Health Act (29 U.S.C. 651 et. seq.) which deals with state jurisdiction and state plans.

(b) *Scope and application.* (1) This section requires chemical manufacturers or importers to assess the hazards of chemicals which they produce or import, and all employers in SIC Codes 20 through 39 (Division D, Standard Industrial Classification Manual) to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers in SIC Codes 20-39.

(2) This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

(3) This section applies to laboratories only as follows:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees; and,

(iii) Employers shall ensure that laboratory employees are apprised of the hazards of the chemicals in their workplaces in accordance with paragraph (h) of this section.

(4) This section does not require labeling of the following chemicals:

(i) Any pesticide as such term is defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et seq.), when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Environmental Protection Agency;

(ii) Any food, food additive, color additive, drug, or cosmetic, including materials intended for use as ingredients in such products (e.g., flavors and fragrances), as such terms are defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.) and regulations issued under that Act, when they are subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Food and Drug Administration;

(iii) Any distilled spirits (beverage alcohols), wine, or malt beverage intended for nonindustrial use, as such terms are defined in the Federal Alcohol Administration Act (27 U.S.C. 201 et seq.) and regulations issued under that Act, when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Bureau of Alcohol, Tobacco, and Firearms, and,

(iv) Any consumer product or hazardous substance as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 et seq.) and Federal Hazardous Substances Act (15 U.S.C. 1261 et seq.) respectively, when subject to a consumer product safety standard or labeling requirement of those Acts, or regulations issued under those Acts by the Consumer Product Safety Commission.

(5) This section does not apply to:

(i) Any hazardous waste as such term is defined by the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901 et seq.), when subject to regulations issued under that Act by the Environmental Protection Agency;

(ii) Tobacco or tobacco products;

(iii) Wood or wood products;

(iv) Articles; and,

(v) Foods, drugs, or cosmetics intended for personal consumption by employees while in the workplace.

(c) *Definitions.* "Article" means a manufactured item: (i) Which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which does not release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use.

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

"Chemical" means any element, chemical compound or mixture of elements and/or compounds.

"Chemical manufacturer" means an employer in SIC Codes 20 through 39 with a workplace where chemical(s) are produced for use or distribution.

"Chemical name" means the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS)

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rules of nomenclature, or a name which will clearly identify the chemical for the purpose of conducting a hazard evaluation.

"Combustible liquid" means any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Common name" means any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

"Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D–323–72.

"Container" means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems are not considered to be containers.

"Designated representative" means any individual or organization to whom an employee gives written authorization to exercise such employee's rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

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

"Distributor" means a business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to manufacturing purchasers.

"Employee" means a worker employed by an employer in a workplace in SIC Codes 20 through 39 who may be exposed to hazardous chemicals under normal operating conditions or foreseeable emergencies, including, but not limited to production workers, line supervisors, and repair or maintenance personnel. Office workers, grounds maintenance personnel, security personnel or non-resident management are generally not included, unless their job performance routinely involves potential exposure to hazardous chemicals.

"Employer" means a person engaged in a business within SIC Codes 20 through 39 where chemicals are either used, or are produced for use or distribution.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Exposure" or "exposed" means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption, etc.), and includes potential (e.g., accidental or possible) exposure.

"Flammable" means a chemical that falls into one of the following categories:

(i) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

(ii) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit.

(iii) "Liquid, flammable" means any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24–1979 (ASTM D 56–79)) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100°F (37.8°C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7–1979 (ASTM D 93–79)) for liquids with a viscosity equal to or greater than 45 SUS a 100°F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278–78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition are excluded from any of the flashpoint determination methods specified above.

"Foreseeable emergency" means any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

"Hazard warning" means any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s).

"Hazardous chemical" means any chemical which is a physical hazard or a health hazard.

"Health hazard" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendix A provides further definitions and explanations of the scope of health hazards covered by this section, and Appendix B describes the criteria to be used to determine whether or not a chemical is to be considered hazardous for purposes of this standard.

"Identity" means any chemical or common name which is indicated on the material safety data sheet (MSDS) for the chemical. The identity used shall permit cross-references to be made

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among the required list of hazardous chemicals, the label and the MSDS.

"Immediate use" means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

"Importer" means the first business with employees within the Customs Territory of the United States which receives hazardous chemicals produced in other countries for the purpose of supplying them to distributors or manufacturing purchasers within the United States.

"Label" means any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals.

"Manufacturing purchaser" means an employer with a workplace classified in SIC Codes 20 through 39 who purchases a hazardous chemical for use within that workplace.

"Material safety data sheet (MSDS)" means written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of this section.

"Mixture" means any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

"Organic peroxide" means an organic compound that contains the bivalent -O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Physical hazard" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

"Produce" means to manufacture, process, formulate, or repackage.

"Pyrophoric" means a chemical that will ignite spontaneously in air at a temperature of 130° F (54.4° C) or below.

"Responsible party" means someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

"Specific chemical identity" means a chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

"Trade secret" means any confidential formula, pattern, process, device, information or compilation of information (including chemical name or other unique chemical identifier) that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

"Unstable (reactive)" means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Use" means to package, handle, react, or transfer.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

"Work area" means a room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present.

"Workplace" means an establishment at one geographical location containing one or more work areas.

(d) *Hazard determination.* (1) Chemical manufacturers and importers shall evaluate chemicals produced in their workplaces or imported by them to determine if they are hazardous. Employers are not required to evaluate chemicals unless they choose not to rely on the evaluation performed by the chemical manufacturer or importer for the chemical to satisfy this requirement.

(2) Chemical manufacturers, importers or employers evaluating chemicals shall identify and consider the available scientific evidence concerning such hazards. For health hazards, evidence which is statistically significant and which is based on at least one positive study conducted in accordance with established scientific principles is considered to be sufficient to establish a hazardous effect if the results of the study meet the definitions of health hazards in this section. Appendix A shall be consulted for the scope of health hazards covered, and Appendix B shall be consulted for the criteria to be followed with respect to the completeness of the evaluation, and the data to be reported.

(3) The chemical manufacturer, importer or employer evaluating chemicals shall treat the following sources as establishing that the chemicals listed in them are hazardous.

(i) 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA); or,

(ii) *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment*, American Conference of Governmental Industrial Hygienists (ACGIH) (latest edition).

The chemical manufacturer, importer, or employer is still responsible for evaluating the hazards associated with the chemicals in these source lists in accordance with the requirements of the standard.

(4) Chemical manufacturers, importers and employers evaluating chemicals shall treat the following sources as establishing that a chemical is a carcinogen or potential carcinogen for hazard communication purposes:

(i) National Toxicology Program (NTP), *Annual Report on Carcinogens* (latest edition);

(ii) International Agency for Research on Cancer (IARC) *Monographs* (latest editions); or

(iii) 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration.

Note.—The *Registry of Toxic Effects of Chemical Substances* published by the National Institute for Occupational Safety and Health indicates whether a chemical has been found by NTP or IARC to be a potential carcinogen.

(5) The chemical manufacturer, importer or employer shall determine the hazards of mixtures of chemicals as follows:

(i) If a mixture has been tested as a whole to determine its hazards, the results of such testing shall be used to determine whether the mixture is hazardous;

(ii) If a mixture has not been tested as a whole to determine whether the mixture is a health hazard, the mixture shall be assumed to present the same health hazards as do the components which comprise one percent (by weight or volume) or greater of the mixture, except that the mixture shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1 percent or greater which is considered to be a carcinogen under paragraph (d)(4) of this section;

(iii) If a mixture has not been tested as a whole to determine whether the mixture is a physical hazard, the chemical manufacturer, importer, or employer may use whatever scientifically valid data is available to evaluate the physical hazard potential of the mixture; and

(iv) If the employer has evidence to indicate that a component present in the mixture in concentrations of less than

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one percent (or in the case of carcinogens, less than 0.1 percent) could be released in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health hazard to employees in those concentrations, the mixture shall be assumed to present the same hazard.

(8) Chemical manufacturers, importers, or employers evaluating chemicals shall describe in writing the procedures they use to determine the hazards of the chemical they evaluate. The written procedures are to be made available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director. The written description may be incorporated into the written hazard communication program required under paragraph (e) of this section.

(e) *Written hazard communication program.* (1) Employers shall develop and implement a written hazard communication program for their workplaces which at least describes how the criteria specified in paragraphs (f), (g), and (h) of this section for labels and other forms of warning, material safety data sheets, and employee information and training will be met, and which also includes the following:

(i) A list of the hazardous chemicals known to be present using an identity that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas);

(ii) The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas; and,

(iii) The methods the employer will use to inform any contractor employers with employees working in the employer's workplace of the hazardous chemicals their employees may be exposed to while performing their work, and any suggestions for appropriate protective measures.

(2) The employer may rely on an existing hazard communication program to comply with these requirements, provided that it meets the criteria established in this paragraph (e).

(3) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director, in accordance with the requirements of 29 CFR 1910.20(e).

(f) *Labels and other forms of warning.* (1) The chemical manufacturer, importer, or distributor shall ensure that each container of hazardous chemicals leaving the work place is labeled, tagged or marked with the following information:

(i) Identity of the hazardous chemical(s);

(ii) Appropriate hazard warnings; and

(iii) Name and address of the chemical manufacturer, importer, or other responsible party.

(2) Chemical manufacturers, importers, or distributors shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged, or marked in accordance with this section in a manner which does not conflict with the requirements of the Hazardous Materials Transportation Act (18 U.S.C. 1801 et seq.) and regulations issued under that Act by the Department of Transportation.

(3) If the hazardous chemical is regulated by OSHA in a substance-specific health standard, the chemical manufacturer, importer, distributor or employer shall ensure that the labels or other forms of warning used are in accordance with the requirements of that standard.

(4) Except as provided in paragraphs (f)(5) and (f)(6) the employer shall ensure that each container of hazardous chemicals in the workplace is labeled, tagged, or marked with the following information:

(i) Identity of the hazardous chemical(s) contained therein; and

(ii) Appropriate hazard warnings.

(5) The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by paragraph (f)(4) of this section to be on a label. The written materials shall be readily accessible to the employees in their work area throughout each work shift.

(6) The employer is not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer.

(7) The employer shall not remove or deface existing labels on incoming containers of hazardous chemicals, unless the container is immediately marked with the required information.

(8) The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

(9) The chemical manufacturer, importer, distributor or employer need not affix new labels to comply with this section if existing labels already convey the required information.

(g) *Material safety data sheets.* (1) Chemical manufacturers and importers shall obtain or develop a material safety data sheet for each hazardous chemical they produce or import. Employers shall have a material safety data sheet for each hazardous chemical which they use.

(2) Each material safety data sheet shall be in English and shall contain at least the following information:

(i) The identity used on the label, and, except as provided for in paragraph (f) of this section on trade secrets:

(A) If the hazardous chemical is a single substance, its chemical and common name(s).

(B) If the hazardous chemical is a mixture which has been tested as a whole to determine its hazards, the chemical and common name(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,

(C) If the hazardous chemical is a mixture which has not been tested as a whole:

(*1*) The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that chemicals identified as carcinogens under paragraph (d)(4) of this section shall be listed if the concentrations are 0.1% or greater; and,

(*2*) The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;

(ii) Physical and chemical characteristics of the hazardous chemical (such as vapor pressure, flash point);

(iii) The physical hazards of the hazardous chemical, including the potential for fire, explosion, and reactivity;

(iv) The health hazards of the hazardous chemical, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the chemical;

(v) The primary route(s) of entry;

(vi) The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or

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recommended by the chemical manufacturer, importer, or employer preparing the material safety data sheet, where available.

(vii) Whether the hazardous chemical is listed in the National Toxicology Program (NTP), *Annual Report on Carcinogens* (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) *Monographs* (latest editions), or by OSHA.

(viii) Any generally applicable precautions for safe handling and use which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks.

(ix) Any generally applicable control measures which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, such as appropriate engineering controls, work practices, or personal protective equipment.

(x) Emergency and first aid procedures.

(xi) The date of preparation of the material safety data sheet or the last change to it, and.

(xii) The name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the material safety data sheet, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

(3) If no relevant information is found for any given category on the material safety data sheet, the chemical manufacturer, importer or employer preparing the material safety data sheet shall mark it to indicate that no applicable information was found.

(4) Where complex mixtures have similar hazards and contents (i.e. the chemical ingredients are essentially the same, but the specific composition varies from mixture to mixture), the chemical manufacturer, importer or employer may prepare one material safety data sheet to apply to all of these similar mixtures.

(5) The chemical manufacturer, importer or employer preparing the material safety data sheet shall ensure that the information recorded accurately reflects the scientific evidence used in making the hazard determination. If the chemical manufacturer, importer or employer becomes newly aware of any significant information regarding the hazards of a chemical, or ways to protect against the hazards, this new information shall be added to the material safety data sheet within three months. If the chemical is not currently being produced or imported the chemical manufacturer or importer shall add the information to the material safety data sheet before the chemical is introduced into the workplace again.

(6) Chemical manufacturers or importers shall ensure that distributors and manufacturing purchasers of hazardous chemicals are provided an appropriate material safety data sheet with their initial shipment, and with the first shipment after a material safety data sheet is updated. The chemical manufacturer or importer shall either provide material safety data sheets with the shipped containers or send them to the manufacturing purchaser prior to or at the time of the shipment. If the material safety data sheet is not provided with the shipment, the manufacturing purchaser shall obtain one from the chemical manufacturer, importer, or distributor as soon as possible.

(7) Distributors shall ensure that material safety data sheets, and updated information, are provided to other distributors and manufacturing purchasers of hazardous chemicals.

(8) The employer shall maintain copies of the required material safety data sheets for each hazardous chemical in the workplace, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s).

(9) Material safety data sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous chemicals in a work area where it may be more appropriate to address the hazards of a process rather than individual hazardous chemicals. However, the employer shall ensure that in all cases the required information is provided for each hazardous chemical, and is readily accessible during each work shift to employees when they are in their work area(s).

(10) Material safety data sheets shall also be made readily available, upon request, to designated representatives and to the Assistant Secretary, in accordance with the requirements of 29 CFR 1910.20(e). The Director shall also be given access to material safety data sheets in the same manner.

(b) *Employee information and training.* Employers shall provide employees with information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new hazard is introduced into their work area.

(1) *Information.* Employees shall be informed of:

(i) The requirements of this section;

(ii) Any operations in their work area where hazardous chemicals are present; and,

(iii) The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and material safety data sheets required by this section.

(2) *Training.* Employee training shall include at least:

(i) Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(ii) The physical and health hazards of the chemicals in the work area.

(iii) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used, and.

(iv) The details of the hazard communication program developed by the employer, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.

(i) *Trade secrets.* (1) The chemical manufacturer, importer or employer may withhold the specific chemical identity, including the chemical name and other specific identification of a hazardous chemical, from the material safety data sheet, provided that:

(i) The claim that the information withheld is a trade secret can be supported.

(ii) Information contained in the material safety data sheet concerning the properties and effects of the hazardous chemical is disclosed.

(iii) The material safety data sheet indicates that the specific chemical identity is being withheld as a trade secret, and.

(iv) The specific chemical identity is made available to health professionals, in accordance with the applicable provisions of this paragraph.

(2) Where a treating physician or nurse determines that a medical emergency exists and the specific chemical identity of a hazardous chemical is necessary for emergency or first-aid treatment, the chemical

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secret status can be made and the necessary protections can be implemented.

(13) Nothing in this paragraph shall be construed as requiring the disclosure under any circumstances of process or percentage of mixture information which is trade secret.

(j) *Effective dates.* Employers shall be in compliance with this section within the following time periods:

(1) Chemical manufacturers and importers shall label containers of hazardous chemicals leaving their workplaces and provide material safety data sheets with initial shipments by November 25, 1985.

(2) Distributors shall be in compliance with all provisions of this section applicable to them by November 25, 1985.

(3) Employers shall be in compliance with all provisions of this section by May 25, 1986, including initial training for all current employees.

Appendix A to § 1910.1200—Health Hazard Definitions (Mandatory)

Although safety hazards related to the physical characteristics of a chemical can be objectively defined in terms of testing requirements (e.g. flammability), health hazard definitions are less precise and more subjective. Health hazards may cause measurable changes in the body—such as decreased pulmonary function. These changes are generally indicated by the occurrence of signs and symptoms in the exposed employee—such as shortness of breath, a non-measurable, subjective feeling. Employees exposed to such hazards must be apprised of both the change in body function and the signs and symptoms that may occur to signal that change.

The determination of occupational health hazards is complicated by the fact that many of the effects or signs and symptoms occur commonly in non-occupationally exposed populations, so that effects of exposure are difficult to separate from normally occurring illnesses. Occasionally, a substance causes an effect that is rarely seen in the population at large, such as angiosarcomas caused by vinyl chloride exposure, thus making it easier to ascertain that the occupational exposure was the primary causative factor. More often, however, the effects are common, such as lung cancer. The situation is further complicated by the fact that most chemicals have not been adequately tested to determine their health hazard potential, and data do not exist to substantiate these effects.

There have been many attempts to categorize effects and to define them in various ways. Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. "Acute" effects usually occur rapidly as a result of short-term exposures, and are of short duration. "Chronic" effects generally occur as a result of long-term exposure, and are of long duration.

The acute effects referred to most frequently are those defined by the American National Standards Institute (ANSI) standard for Precautionary Labeling of Hazardous Industrial Chemicals (Z129.1-1982)—irritation, corrosivity, sensitization and lethal dose. Although these are important health effects, they do not adequately cover the considerable range of acute effects which may occur as a result of occupational exposure, such as, for example, narcosis.

Similarly, the term chronic effect is often used to cover only carcinogenicity, teratogenicity and mutagenicity. These effects are obviously a concern in the workplace, but again, do not adequately cover the area of chronic effects, excluding, for example, blood dyscrasias (such as anemia), chronic bronchitis and liver atrophy.

The goal of defining precisely, in measurable terms, every possible health effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished. This does not negate the need for employees to be informed of such effects and protected from them.

Appendix B, which is also mandatory, outlines the principles and procedures of hazard assessment.

For purposes of this section, any chemicals which meet any of the following definitions, as determined by the criteria set forth in Appendix B are health hazards.

1. *Carcinogen:* A chemical is considered to be a carcinogen if:

(a) It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or

(b) It is listed as a carcinogen or potential carcinogen in the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP) (latest edition); or,

(c) It is regulated by OSHA as a carcinogen.

2. *Corrosive:* A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

3. *Highly toxic:* A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

4. *Irritant:* A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

5. *Sensitizer:* A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

6. *Toxic:* A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of

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manufacturer, importer, or employer shall immediately disclose the specific chemical identity of a trade secret chemical to that treating physician or nurse, regardless of the existence of a written statement of need or a confidentiality agreement. The chemical manufacturer, importer, or employer may require a written statement of need and confidentiality agreement, in accordance with the provisions of paragraphs (i) (3) and (4) of this section, as soon as circumstances permit.

(3) In non-emergency situations, a chemical manufacturer, importer, or employer shall, upon request, disclose a specific chemical identity, otherwise permitted to be withheld under paragraph (i)(1) of this section, to a health professional (i.e. physician, industrial hygienist, toxicologist, or epidemiologist) providing medical or other occupational health services to exposed employee(s) if:

(i) the request is in writing;

(ii) The request describes with reasonable detail one or more of the following occupational health needs for the information:

(A) To assess the hazards of the chemicals to which employees will be exposed;

(B) To conduct or assess sampling of the workplace atmosphere to determine employee exposure levels;

(C) To conduct pre-assignment or periodic medical surveillance of exposed employees;

(D) To provide medical treatment to exposed employees;

(E) To select or assess appropriate personal protective equipment for exposed employees;

(F) To design or assess engineering controls or other protective measures for exposed employees; and,

(G) To conduct studies to determine the health effects of exposure.

(iii) The request explains in detail why the disclosure of the specific chemical identity is essential and that, in lieu thereof, the disclosure of the following information would not enable the health professional to provide the occupational health services described in paragraph (ii) of this section:

(A) The properties and effects of the chemical;

(B) Measures for controlling workers' exposure to the chemical;

(C) Methods of monitoring and analyzing worker exposure to the chemical; and,

(D) Methods of diagnosing and treating harmful exposures to the chemical;

(iv) The request includes a description of the procedures to be used to maintain the confidentiality of the disclosed information; and,

(v) The health professional and the employer or contractor of the health professional's services (i.e., downstream employer, labor organization, or individual employee), agree in a written confidentiality agreement that the health professional will not use the trade secret information for any purpose other than the health need(s) asserted and agree not to release the information under any circumstances other than to OSHA, as provided in paragraph (i)(6) of this section, except as authorized by the terms of the agreement or by the chemical manufacturer, importer, or employer.

(4) The confidentiality agreement authorized by paragraph (i)(3)(iv) of this section:

(i) May restrict the use of the information to the health purposes indicated in the written statement of need;

(ii) May provide for appropriate legal remedies in the event of a breach of the agreement, including stipulation of a reasonable pre-estimate of likely damages; and,

(iii) May not include requirements for the posting of a penalty bond.

(5) Nothing in this standard is meant to preclude the parties from pursuing non-contractual remedies to the extent permitted by law.

(6) If the health professional receiving the trade secret information decides that there is a need to disclose it to OSHA, the chemical manufacturer, importer, or employer who provided the information shall be informed by the health professional prior to, or at the same time as, such disclosure.

(7) If the chemical manufacturer, importer, or employer denies a written request for disclosure of a specific chemical identity, the denial must:

(i) Be provided to the health professional within thirty days of the request;

(ii) Be in writing;

(iii) Include evidence to support the claim that the specific chemical identity is a trade secret;

(iv) State the specific reasons why the request is being denied; and,

(v) Explain in detail how alternative information may satisfy the specific medical or occupational health need without revealing the specific chemical identity.

(8) The health professional whose request for information is denied under paragraph (i)(3) of this section may refer the request and the written denial of the request to OSHA for consideration.

(9) When a health professional refers the denial to OSHA under paragraph (i)(8) of this section, OSHA shall consider the evidence to determine if:

(i) The chemical manufacturer, importer, or employer has supported the claim that the specific chemical identity is a trade secret;

(ii) The health professional has supported the claim that there is a medical or occupational health need for the information; and,

(iii) The health professional has demonstrated adequate means to protect the confidentiality.

(10) (i) If OSHA determines that the specific chemical identity requested under paragraph (i)(3) of this section is not a *bona fide* trade secret, or that it is a trade secret but the requesting health professional has a legitimate medical or occupational health need for the information, has executed a written confidentiality agreement, and has shown adequate means to protect the confidentiality of the information, the chemical manufacturer, importer, or employer will be subject to citation by OSHA.

(ii) If a chemical manufacturer, importer, or employer demonstrates to OSHA that the execution of a confidentiality agreement would not provide sufficient protection against the potential harm from the unauthorized disclosure of a trade secret specific chemical identity, the Assistant Secretary may issue such orders or impose such additional limitations or conditions upon the disclosure of the requested chemical information as may be appropriate to assure that the occupational health services are provided without an undue risk of harm to the chemical manufacturer, importer, or employer.

(11) If, following the issuance of a citation and any protective orders, the chemical manufacturer, importer, or employer continues to withhold the information, the matter is referrable to the Occupational Safety and Health Review Commission for enforcement of the citation. In accordance with Commission rules, the Administrative Law Judge may review the citation and supporting documentation *in camera* or issue appropriate protective orders.

(12) Notwithstanding the existence of a trade secret claim, a chemical manufacturer, importer, or employer shall, upon request, disclose to the Assistant Secretary any information which this section requires the chemical manufacturer, importer, or employer to make available. Where there is a trade secret claim, such claim shall be made no later than at the time the information is provided to the Assistant Secretary so that suitable determinations of trade

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more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

7. *Target organ effects.* The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but are not intended to be all-inclusive.

a. Hepatotoxins	Chemicals which produce liver damage
Signs and Symptoms	Jaundice; liver enlargement
Chemicals	Carbon tetrachloride; nitrosamines
b. Nephrotoxins	Chemicals which produce kidney damage
Signs and Symptoms	Edema; proteinuria
Chemicals	Halogenated hydrocarbons; uranium
c. Neurotoxins	Chemicals which produce their primary toxic effects on the nervous system
Signs and Symptoms	Narcosis; behavioral changes; decrease in motor functions
Chemicals	Mercury; carbon disulfide
d. Agents which act on the blood or hemopoietic system	Decrease hemoglobin function; deprive the body tissues of oxygen
Signs and Symptoms	Cyanosis; loss of consciousness
Chemicals	Carbon monoxide; cyanides
e. Agents which damage the lung	Chemicals which irritate or damage the pulmonary tissue
Signs and Symptoms	Cough; tightness in chest; shortness of breath
Chemicals	Silica; asbestos
f. Reproductive toxins	Chemicals which affect the reproductive capabilities including chromosome damage (mutations) and effects on fetuses (teratogenesis)
Signs and Symptoms	Birth defects; sterility
Chemicals	Lead; DBCP
g. Cutaneous hazards	Chemicals which affect the dermal layer of the body
Signs and Symptoms	Defatting of the skin; rashes; irritation
Chemicals	Ketones; chlorinated compounds
h. Eye hazards	Chemicals which affect the eye or visual capacity
Signs and Symptoms	Conjunctivitis; corneal damage
Chemicals	Organic solvents; acids

Appendix B to § 1910.1200—Hazard Determination (Mandatory)

The quality of a hazard communication program is largely dependent upon the adequacy and accuracy of the hazard determination. The hazard determination requirement of this standard is performance-oriented. Chemical manufacturers, importers, and employers evaluating chemicals are not required to follow any specific methods for determining hazards, but they must be able to demonstrate that they have adequately ascertained the hazards of the chemicals produced or imported in accordance with the criteria set forth in this Appendix.

Hazard evaluation is a process which relies heavily on the professional judgment of the evaluator, particularly in the area of chronic hazards. The performance-orientation of the hazard determination does diminish the duty of the chemical manufacturer, importer or employer to conduct a thorough evaluation, examining all relevant data and producing a scientifically defensible evaluation. For purposes of this standard, the following criteria shall be used in making hazard determinations that meet the requirements of this standard.

1. *Carcinogenicity:* As described in paragraph (d)(4) and Appendix A of this section, a determination by the National Toxicology Program, the International Agency for Research on Cancer, or OSHA that a chemical is a carcinogen or potential carcinogen will be considered conclusive evidence for purposes of this section.

2. *Human data.* Where available, epidemiological studies and case reports of adverse health effects shall be considered in the evaluation.

3. *Animal data:* Human evidence of health effects in exposed populations is generally not available for the majority of chemicals produced or used in the workplace. Therefore, the available results of toxicological testing in animal populations shall be used to predict the health effects that may be experienced by exposed workers. In particular, the definitions of certain acute hazards refer to specific animal testing results (see Appendix A).

4. *Adequacy and reporting of data:* The results of any studies which are designed and conducted according to established scientific principles, and which report statistically significant conclusions regarding the health effects of a chemical, shall be a sufficient basis for a hazard determination and reported on any material safety data sheet. The chemical manufacturer, importer, or employer may also report the results of other scientifically valid studies which tend to refute the findings of hazard.

Appendix C to § 1910.1200—Information Sources (Advisory)

The following is a list of available data sources which the chemical manufacturer, importer, or employer may wish to consult to evaluate the hazards of chemicals they produce or import:

— Any information in their own company files such as toxicity testing results or illness experience of company employees.

— Any information obtained from the supplier of the chemical such as material safety data sheets or product safety bulletins.

— Any pertinent information obtained from the following source list (latest editions should be used):

Condensed Chemical Dictionary
Van Nostrand Reinhold Co., 135 West 50th Street, New York, NY 10020

The Merck Index: An Encyclopedia of Chemicals and Drugs
Merck and Company, Inc., 126 E. Lincoln Avenue, Rahway, NJ 07065

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man
Geneva: World Health Organization, International Agency for Research on Cancer, 1972–1977. (Multivolume work.)
49 Sheridan Street, Albany, New York

Industrial Hygiene and Toxicology, by F. A. Patty
John Wiley & Sons, Inc., New York, NY (Five volumes)

Clinical Toxicology of Commercial Products
Gleason, Gosselin and Hodge

Casarett and Doull's Toxicology: The Basic Science of Poisons
Doull, Klaassen, and Amdur, Macmillan Publishing Co., Inc., New York, NY

Industrial Toxicology, by Alice Hamilton and Harriet L. Hardy
Publishing Sciences Group, Inc., Acton, MA

Toxicology of the Eye, by W. Morton Grant
Charles C. Thomas, 301–327 East Lawrence Avenue, Springfield, IL

Recognition of Health Hazards in Industry
William A. Burgess, John Wiley and Sons, 605 Third Avenue, New York, NY 10158

Chemical Hazards of the Workplace
Nick H. Proctor and James P. Hughes, J. P. Lipincott Company, 6 Winchester Terrace, New York, NY 10022

Handbook of Chemistry and Physics
Chemical Rubber Company, 18901 Cranwood Parkway, Cleveland, OH 44128

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes
American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Bldg. D-5, Cincinnati, OH 45211

Note.—The following documents are on sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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Occupational Health Guidelines
NIOSH/OSHA (NIOSH Pub No 81-123)
NIOSH/OSHA Pocket Guide to Chemical Hazards
NIOSH Pub No 78-210
Registry of Toxic Effects of Chemical Substances
U.S Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health (NIOSH Pub No 80-102)
The Industrial Environment—Its Evaluation and Control
U.S Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health (NIOSH Pub No 74-117)
Miscellaneous Documents—National Institute for Occupational Safety and Health
1 Criteria for a recommended standard . . . Occupational Exposure to "——"
2 Special Hazard Reviews
3 Occupational Hazard Assessment
4 Current Intelligence Bulletins

Bibliographic Data BAses

Service Provider and File Name

Bibliographic Retrieval Services (BRS), Corporation Park, Bldg 702, Scotia, New York 12302
AGRICOLA
BIOSIS PREVIEWS
CA CONDENSATES
CA SEARCH
DRUG INFORMATION
MEDLARS
MEDLOC
NTIS
POLLUTION ABSTRACTS
SCIENCE CITATION INDEX
SSIE

Lockheed—DIALOG, Lockheed Missiles & Space Company Inc., P.O. Box 44481, San Francisco, CA 94144
AGRICOLA
BIOSIS PREV. 1972–PRESENT
BIOSIS PREV. 1969–71
CA CONDENSATES 1970–71
CA SEARCH 1972–76
CA SEARCH 1977–PRESENT
CHEMNAME
CONFERENCE PAPERS INDEX
FOOD SCIENCE & TECH. ABSTR.
FOODS ADLIBRA
INTL. PHARMACEUTICAL ABSTR.
NTIS
POLLUTION ABSTRACTS
SCISEARCH 1978–PRESENT
SCISEARCH 1974–77
SSIE CURRENT RESEARCH

SDC—ORBIT, SDC Search Service, Department No. 2230 Pasadena, CA 91051
AGRICOLA
BIOCODES
BIOSIS/BIO6873
CAS6771/CAS7276
CAS77
CHEMDEX
CONFERENCE
ENVIROLINE
LABORDOC
NTIS
POLLUTION
SSIE

Chemical Information System (CIS), Chemical Information Systems Inc., 7215 Yorke Road, Baltimore, MD 21212
Structure & Nomenclature Search System
Acute Toxicity (RTECS)
Clinical Toxicology of Commercial Products
Oil and Hazardous Materials Technical Assistance Data System

National Library of Medicine, Department of Health and Human Services, Public Health Service, National Institutes of Health, Bethesda, MD 20209
Toxicology Data Bank (TDB)
MEDLINE
TOXLINE
CANCERLIT
RTECS

[FR Doc. 83-31527 Filed 11-23-83 8:45 am]
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ATTACHMENT I

HAZARDOUS CHEMICAL CLASSIFICATION GUIDE (FOR USE IN COMPLYING WITH OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200)

SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Acetaldehyde	X	X		
Acetic acid	X	X		
Acetic anhydride	X	X		
Acetone	X	X		
Acetonitrile	X	X		
2-Acetylaminofluorene	X			
Acetylene		X		
2-Acetylaminofluorene			X	
Acetylene dichloride, see 1, 2-Dichloroethylene				
Acetylene tetrabromide	X	X		
Acetylsalicylic acid (Aspirin)		X		
Acrolein	X	X		
Acrylamide	X	X		
Acrylic acid		X		
Acrylonitrile	X	X	X	X
Adriamycin				X
Aflatoxins			X	X
Aldrin	X	X		
Allyl alcohol	X	X		
Allyl chloride	X	X		
Allyl glycidyl ether (AGE)	X	X		
Allyl propyl disulfide	X	X		
alpha-Alumina		X		
Aluminum		X		
Metal & oxide		X		
Pyro powders		X		
Welding fumes		X		
Soluble salts		X		
Alkyls (NOC)		X		
2-Aminoanthraquinone			X	
o-Aminoazotoluene				X
4-Aminobiphenyl, see 4-Aminodiphenyl				
4-Aminodiphenyl	X	X	X	X
2-Aminoethanol, see Ethanolamine				
1-Amino-2-methylanthraquinone			X	
2-Aminopyridine	X	X		
2-Amino-5(5-nitro-2-furyl)-1,3,4-thiadiazole				X
3-Amino 1, 2, 4-triazole, see Amitrole				
Amitrole		X	X	X
Ammonia	X	X		
Ammonium chloride fume		X		
Ammonium sulfamate (Ammate)	X	X		
n-Amyl acetate	X	X		
sec-Amyl acetate	X	X		

Prepared by: Chemical Section Committee 1
National Safety Council
May, 1984

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Aniline & homologues	X	X		
Anisidine (o-,p-isomers)	X	X		
o-Anisidine			X	X
o-Anisidine hydrochloride			X	
Antimony & compounds, as Sb	X	X		
Antimony trioxide		X		
Handling and use, as Sb		X		
Production		X		
ANTU (alpha naphthyl thiourea)	X	X		
Aramite®			X	X
Argon		X		
Arsenic & soluble compounds, as As	X	X	X	
Arsenic trioxide production		X		
Arsine	X	X		
Asbestos, also see MINERAL DUSTS, page 22	X	X	X	X
Asphalt (petroleum) fumes		X		
Atrazine		X		
Auramine manufacture			X	
Azaserine				X
Azinphosmethyl (Guthion®)	X	X		
Barium, soluble compounds, as Ba	X	X		
BCNU (bischloroethyl nitrosourea)				X
Benomyl		X		
Benz(a)anthracene			X	X
Benzene	X	X	X	
Benzidine	X	X	X	X
p-Benzoquinone, see Quinone				
Benzo(b)fluoranthene			X	X
Benzo(a)pyrene		X	X	X
Benzoyl peroxide	X	X		
Benzotrichloride				X
Benzyl chloride	X	X		
Benzyl violet 4B				X
Beryllium and beryllium compounds	X	X	X	X
Biphenyl, see Diphenyl				
Bismuth telluride		X		
Se-doped		X		
Borates, tetra, sodium salts,		X		
Anhydrous		X		
Decahydrate		X		
Pentahydrate		X		
Boron oxide	X	X		
Boron tribromide		X		
Boron trifluoride	X	X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Bromacil		X		
Bromine	X	X		
Bromine pentafluoride		X		
Bromochloromethane, see Chlorobromomethane				
Bromoform	X	X		
1,3-Butadiene	X	X		
Butane		X		
Butanethiol, see Butyl mercaptan				
2-Butanone, see Methyl ethyl ketone (MEK)				
2-Butoxyethanol (Butyl Cellosolve)	X	X		
n-Butyl acetate	X	X		
sec-Butyl acetate	X	X		
tert-Butyl acetate	X	X		
Butyl acrylate		X		
n-Butyl alcohol	X	X		
sec-Butyl alcohol	X	X		
tert-Butyl alcohol	X	X		
Butylamine	X	X		
tert-Butyl chromate, as CrO_3	X	X		
n-Butyl glycidyl ether (BGE)	X	X		
n-Butyl lactate		X		
Butyl mercaptan (Butanethiol)	X	X		
alpha-sec-Butylphenol		X		
p-tert-Butyltoluene	X	X		
beta-Butyrolactone				X
Cadmium Dust & salts, as Cd	X	X	X	
Cadmium Chloride				X
Cadmium oxide		X		X
Fume, as Cd	X	X		
Production		X		
Cadmium sulfate				X
Cadmium sulfide				X
Calcium carbonate/marble		X		
Calcium chromate				X
Calcium cyanamide		X		
Calcium hydroxide		X		
Calcium oxide	X	X		
Calcium silicate		X		
Camphor, synthetic	X	X		
Caprolactam		X		
Dust		X		
Vapor		X		
Captafol		X		
Captan		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Carbaryl (Sevin®)	X	X		
Carbofuran		X		
Carbon black	X	X		
Carbon dioxide	X	X		
Carbon disulfide	X	X		
Carbon monoxide	X	X		
Carbon tetrabromide		X		
Carbon tetrachloride	X	X	X	X
Carbonyl chloride, see Phosgene				
Carbonyl fluoride		X		
Catechol (Pyrocatechol)		X		
CCNU (1-(2-Chloroethyl)-3cylcohexyl-1-nitrosourea)				X
Cellulose (paper fiber)		X		
Cesium hydroxide		X		
Chlorambucil			X	X
Chlordane	X	X		
Chlordecone, see Kepone®				
Chlorinated camphene	X	X	X	X
Chlorinated diphenyl oxide	X	X		
Chlorine	X	X		
Chlorine dioxide	X	X		
Chlorine trifluoride	X	X		
Chlornaphazine			X	
Chloroacetaldehyde	X	X		
alpha-Chloroacetophenone (Phenacyl chloride)	X	X		
Chloroacetyl chloride		X		
Chlorobenzene (Monochlorobenzene)	X	X		
o-Chlorobenzylidene malononitrile (OCBM)	X	X		
Chlorobromomethane (Bromochloromethane)	X	X		
2-Chloro-1,3-butadine, see B-Chloroprene				
Chlorodifluoromethane		X		
1-Chloro, 2, 3-epoxy-propane, see Epichlorohydrin				
2-Chloroethanol, see Ethylene chlorohydrin				
N, N-bis (2-chloroethyl)-2-naphthylamine, see Chlornaphazine				
Chloroethylene, see Vinyl chloride				
Chloroform (trichloromethane)	X	X	X	X
bis-Chloromethyl ether	X	X	X	X
Chloromethyl methyl ether, technical grade		X	X	X
1-Chloro-1-nitropropane	X	X		
Chloropentafluoroethane		X		
4-Chloro-o-phenylenediamine				X
Chloropicrin (nitrotrichloromethane)	X	X		
B-Chloroprene (2-chloro-1,3-butadiene)	X	X		
o-Chlorostyrene		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
o-Chlorotoluene		X		
2-Chloro-6-(trichloromethyl) pyridine, see Nitrapyrin				
Chlorpyrifos		X		
Chromic acid and chromates	X	X		
Chromite ore processing (Chromate), as Cr		X		
Chromium Metal	X	X	X	
Chromium (II) compounds, as Cr	X	X	X	
Chromium (III) compounds, as Cr	X	X	X	
Chromium (VI) compounds, as Cr	X	X	X	
Water soluble	X	X	X	
Certain water insoluble	X	X	X	
Chromyl chloride		X		
Chrysene		X		
Citrus Red No. 2				X
Clopidol		X		
Coal dust, see MINERAL DUSTS, page 22				
Coal tar pitch volatiles	X	X		
(as benzene soluble fractions; anthracene, BeP, phenanthrene, acridine, chrysene, pyrene)				
Cobalt, as Co metal, dust & fume	X	X		
Cobalt carbonyl, as Co		X		
Cobalt hydrocarbonyl, as Co		X		
Coke oven emissions	X		X	
Copper				
Fume	X	X		
Dusts & mists, as Cu	X	X		
Cotton dust, raw	X	X		
Crag® herbicide	X			
p-Cresidine			X	X
Cresol, all isomers	X	X		
Crotonaldehyde	X	X		
Crufomate		X		
Cumene	X	X		
Cupferron			X	
Cyanamide		X		
Cyanides, as CN	X	X		
Cyanogen		X		
Cyanogen chloride		X		
Cycasin			X	X
Cyclohexane	X	X		
Cyclohexanol	X	X		
Cyclohexanone	X	X		
Cyclohexene	X	X		
Cyclohexylamine		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
o-Chlorotoluene		X		
2-Chloro-6-(trichloromethyl) pyridine, see Nitrapyrin				
Chlorpyrifos		X		
Chromic acid and chromates	X	X		
Chromite ore processing (Chromate), as Cr		X		
Chromium Metal	X	X	X	
Chromium (II) compounds, as Cr	X	X	X	
Chromium (III) compounds, as Cr	X	X	X	
Chromium (VI) compounds, as Cr	X	X	X	
Water soluble	X	X	X	
Certain water insoluble	X	X	X	
Chromyl chloride		X		
Chrysene		X		
Citrus Red No. 2				X
Clopidol		X		
Coal dust, see MINERAL DUSTS, page 22				
Coal tar pitch volatiles	X	X		
(as benzene soluble fractions; anthracene, BaP, phenanthrene, acridine, chrysene, pyrene)				
Cobalt, as Co metal, dust & fume	X	X		
Cobalt carbonyl, as Co		X		
Cobalt hydrocarbonyl, as Co		X		
Coke oven emissions	X		X	
Copper				
Fume	X	X		
Dusts & mists, as Cu	X	X		
Cotton dust, raw	X	X		
Crag® herbicide	X			
p-Cresidine			X	X
Cresol, all isomers	X	X		
Crotonaldehyde	X	X		
Crufomate		X		
Cumene	X	X		
Cupferron			X	
Cyanamide		X		
Cyanides, as CN	X	X		
Cyanogen		X		
Cyanogen chloride		X		
Cycasin			X	X
Cyclohexane	X	X		
Cyclohexanol	X	X		
Cyclohexanone	X	X		
Cyclohexene	X	X		
Cyclohexylamine		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Cyclonite		X		
Cyclopentadiene	X	X		
Cyclopentane		X		
Cyclophosphamide			X	X
Cyhexatin		X		
2,4-D	X	X		
DDT (Dichlorodiphenyltrichloroethane)	X			X
DDVP	X			X
Dacarbazine				X
Daunomycin				X
Decaborane	X	X		
Demeton®	X	X		
Diacetone alcohol (4-hydroxy-4 methyl-2-pentanone)	X	X		X
N,N'-Diacetylbenzidine			X	X
2,4-Diaminoanisole sulfate			X	X
4,4'-Diaminodiphenyl ether				X
1,2-Diaminoethane, see Ethylenediamine				
2,4-Diaminotoluene			X	X
Diazinon		X		
Diazomethane	X	X		
Dibenz (a,h) acridine			X	X
Dibenz (a,j) acridine			X	X
Dibenz (a,h) anthracene			X	X
7H-Dibenzo (c,g) carbazole			X	X
Dibenzo (a,e) pyrene				X
Dibenzo (a,h) pyrene			X	X
Dibenzo (a,i) pyrene			X	X
Diborane	X	X		
1,2 Dibromo-3-Chloropropane	X		X	X
1,2-Dibromoethane, see Ethylene dibromide				
2-N-Dibutylaminoethanol		X		
Dibutyl phosphate	X	X		
Dibutyl phthalate	X	X		
Dichloroacetylene		X		
o-Dichlorobenzene	X	X		
p-Dichlorobenzene	X	X		
3,3'-Dichlorobenzidine (and its salts)	X	X	X	X
3,3'-Dichloro-4,4'-diaminodiphenyl ether				X
Dichlorodifluoromethane	X	X		
1,3-Dichloro-5,5-dimethyl hydantoin	X	X		
1,1-Dichloroethane (Ethylidene chloride)	X	X		
1,2-Dichloroethane, see Ethylene dichloride				
1,1-Dichloroethylene, see Vinylidene chloride				
1,2-Dichloroethylene (Acetylene dichloride)	X	X		

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SUBSTANCE/PROCESS	SOURCE[a] OSHA	ACGIH	NTP	IARC
Dichloroethyl ether	X	X		
Dichlorofluoromethane		X		
Dichloromethane, see Methylene chloride				
Dichloromonofluoromethane	X			
1,1-Dichloro-1-nitroethane	X	X		
1,2-Dichloropropane, see Propylene dichloride				
Dichloropropene		X		
2,2-Dichloropropionic acid		X		
Dichlorotetrafluoroethane	X	X		
Dichlorvos		X		
Dicrotophos		X		
Dicyclopentadiene		X		
Dicyclopentadienyl iron		X		
Dieldrin	X	X		
Diepoxybutane			X	X
Diethanololamine		X		
Diethylamine	X	X		
Diethylaminoethanol	X	X		
Diethylene triamine		X		
Diethyl ether, see Ethyl ether				
Di (2-ethylhexyl) phthalate			X	X
1,2-Diethylhydrazine				X
Diethyl ketone		X		
Diethyl phthalate		X		
Diethylstilbestrol			X	X
Diethyl sulfate				X
Difluorodibromomethane	X	X		
Diglycidyl ether (DGE)	X	X		
Dihydroxybenzene, see Hydroquinone				
Dihydrosafrole				X
Diisobutyl ketone (2,6-Dimethyl-4-heptanone)	X	X		
Diisopropylamine	X	X		
3, 3'-Dimethoxybenzidine (o-Dianisidine)			X	X
Dimethoxymethane, see Methylal				
Dimethyl acetamide	X	X		
Dimethylamine	X	X		
p-Dimethylaminoazobenzene	X		X	X
Dimethylaminobenzene, see Xylidene				
trans-2 [(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole				X
Dimethylaniline (N, N-Dimethylaniline)	X	X		
Dimethylbenzene, see Xylene				
3,3'-Dimethylbenzidine (o-Tolidine)			X	X
Dimethyl carbamyl chloride		X	X	X
Dimethyl-1,2-dibromo-2-dichloroethyl phosphate, See Naled (Dibrom)				

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Dimethylformamide	X	X		
2,6-Dimethyl-4-heptanone, see Diisobutyl ketone				
1,1-Dimethylhydrazine	X	X		X
1,2-Dimethylhydrazine				X
Dimethylphthalate	X	X		
Dimethyl sulfate	X	X	X	X
Dinitolmide (3,5-Dinitro-o-toluamide)		X		
Dinitrobenzene (all isomers)	X	X		
Dinitro-o-cresol	X	X		
3,5-Dinitro-o-toluamide, see Dinitolmide				
Dinitrotoluene	X	X		
1,4-Dioxane, tech. grade (Diethylene dioxide)	X	X	X	X
Dioxathion		X		
Diphenyl (Biphenyl)	X	X		
Diphenylamine		X		
Diphenylmethane diisocyanate, See Methylene bisphenyl isocyanate (MDI)				
Dipropylene glycol methyl ether	X	X		
Dipropyl ketone		X		
Diquat		X		
Direct Black 38			X	X
Direct Blue 6			X	X
Di-sec, octyl phthalate (Di-2-ethylhexylphthalate)	X	X		
Disulfiram		X		
Disulfoton		X		
2,6-Ditert. butyl-p-cresol		X		
Diuron		X		
Divinyl benzene		X		
Emery		X		
Endosulfan		X		
Endrin	X	X		
Epichlorohydrin (1-Chloro,2,3-epoxy-propane)	X	X		X
EPN	X	X		
1,2-Epoxypropane, see Propylene oxide				
2,3-Epoxy-1-propanol, see Glycidol				
Ethane		X		
Ethanethiol, see Ethyl mercaptan				
Ethanolamine (2-Aminoethanol)	X	X		
Ethinyloestradiol				X
Ethion		X		
2-Ethoxyethanol (Glycol monoethyl ether)	X	X		
2-Ethoxyethyl acetate (cellosolve acetate)	X	X		

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	SOURCE*			
SUBSTANCE/PROCESS	OSHA	ACGIH	NTP	IARC
Ethyl acetate	X	X		
Ethyl acrylate	X	X		
Ethyl alcohol (Ethanol)	X	X		
Ethylamine	X	X		
Ethyl amyl ketone (5-methyl-3-heptanone)	X	X		
Ethyl benzene	X	X		
Ethyl bromide	X	X		
Ethyl butyl ketone (3-heptanone)	X	X		
Ethyl chloride	X	X		
Ethylene		X		
Ethylene chlorohydrin (2 Chloroethanol)	X	X		
Ethylenediamine (1,2 Diaminoethane)	X	X		
Ethylene dibromide (1,2 Dibromoethane)	X	X	X	X
Ethylene dichloride (1,2 Dichloroethane)	X	X	X	X
Ethylene glycol				
Particulate		X		
Vapor		X		
Ethylene glycol dinitrate and/or Nitroglycerin	X	X		
Ethylene glycol methyl ether acetate, see 2-Methoxyethyl acetate				
Ethylene oxide	X	X		
Ethyleneimine	X	X		
Ethylene thiourea			X	X
Ethyl ether (Diethyl ether)	X	X		
Ethyl formate	X	X		
Ethylidene chloride, see 1,1-Dichloroethane				
Ethylidene norbornene		X		
Ethyl mercaptan (Ethanethiol)	X	X		
Ethyl methanesulfonate				X
N-Ethylmorpholine	X	X		
Ethyl silicate	X	X		
Fensulfothion		X		
Fenthion		X		
Ferbam	X	X		
Ferrovanadium dust	X	X		
Fibrous glass dust (Glass, fibrous or dust)		X		
Fluorides, as F	X	X		
Fluorine	X	X		
Fluorotrichloromethane, see Trichlorofluoromethane				
Fonofos		X		
Formaldehyde	X	X	X	
Formaldehyde gas				X
Formamide		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Formic acid	X	X		
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole				X
Furfural	X	X		
Furfuryl alcohol	X	X		
Gasoline		X		
Germanium tetrahydride		X		
Glass, fibrous or dust, see Fibrous glass dust				
Glutaraldehyde		X		
Glycerin mist		X		
Glycidaldehyde				X
Glycidol (2,3-Epoxy-1-propanol)	X	X		
Glycol monoethyl ether, see 2-Ethoxyethanol				
Graphite (Natural), see MINERAL DUSTS, page 22				
Graphite (Synthetic)		X		
Guthion®, see Azinphosmethyl				
Gypsum		X		
Hafnium	X	X		
Helium		X		
Hematite underground mining			X	
Heptachlor	X	X		
Heptane (n-Heptane)	X	X		
2-Heptanone, see Methyl n-amyl ketone				
3-Heptanone, see Ethyl butyl ketone				
Hexachlorobenzene			X	X
Hexachlorobutadiene		X		
Hexachlorocyclohexane isomers			X	
Hexachlorocyclopentadiene		X		
Hexachloroethane	X	X		
Hexachloronophthalene	X	X		
Hexafluoroacetone		X		
Hexamethyl phosphoramide		X		X
Hexane (n-Hexane)	X	X		
Other isomers		X		
2-Hexanone, see Methyl n-butyl ketone				
Hexone, see Methyl isobutyl ketone				
sec-Hexyl acetate	X	X		
Hexylene glycol		X		
Hydrazine	X	X	X	X
Hydrazine sulfate			X	
Hydrazobenzene			X	
Hydrogen		X		
Hydrogenated terphenyls		X		
Hydrogen bromide	X	X		
Hydrogen chloride	X	X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Hydrogen cyanide	X	X		
Hydrogen fluoride, as F		X		
Hydrogen peroxide	X	X		
Hydrogen selenide, as Se	X	X		
Hydrogen sulfide	X	X		
Hydroquinone (Dihydroxybenzene)	X	X		
4-Hydroxy-4-methyl-2-pentanone, see Diacetone alcohol				
2-Hydroxypropyl acrylate		X		
Indene		X		
Indeno (1,2-cd) pyrene				X
Indeno (1,2,3-cd) pyrene			X	
Indium & compounds, as In		X		
Inert (nuisance) dust, see MINERAL DUSTS, page 22				
Iodine	X	X		
Iodoform		X		
Iron dextran complex			X	X
Iron oxide fume (Fe_2O_3), as Fe	X	X		
Iron pentacarbonyl, as Fe		X		
Iron salts, soluble, as Fe		X		
Isoamyl acetate	X	X		
Isoamyl alcohol	X	X		
Isobutyl acetate	X	X		
Isobutyl alcohol	X	X		
Isooctyl alcohol		X		
Isophorone	X	X		
Isophorone diisocyanate		X		
Isopropoxyethanol		X		
Isopropyl acetate	X	X		
Isopropyl alcohol	X	X		
Isopropylamine	X	X		
Manufacture (strong-acid process)			X	
N-Isopropylaniline		X		
Isopropyl ether	X	X		
Isopropyl glycidyl ether (IGE)	X	X		
Isosafrole				X
Kaolin		X		
Kepone® (Chlordecone)			X	X
Ketene	X	X		
Lasiocarpine				X
Lead, inorg., dusts & fumes, as Pb	X	X		
Lead acetate			X	X
Lead arsenate, as $Pb_3(AsO_4)_2$		X		
Lead chromate, as Cr		X		X

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Lead phosphate			X	X
Lead subacetate				X
Limestone		X		
Lindane	X	X	X	
Lithium hydride	X	X		
L.P.G. (Liquified petroleum gas)	X	X		
Magnesite		X		
Magnesium oxide fume	X	X		
Malathion	X	X		
Maleic anhydride	X	X		
Manganese, as Mn; Dust & compounds	X	X		
Fume	X	X		
Manganese cyclopentadienyl tricarbonyl, as Mn		X		
Manganese tetroxide		X		
Marble/calcium carbonate		X		
Melphalan			X	X
Mercury, as Hg; Alkyl compounds	X	X		
All forms except alkyl; Vapor	X	X		
Aryl & inorganic compounds	X	X		
Merphalan				X
Mesityl oxide	X	X		
Mestranol				X
Methacrylic acid		X		
Methane		X		
Methanethiol, see Methyl mercaptan				
Methomyl		X		
Methoxsalen with ultra-violet A therapy (PUVA)				X
Methoxychlor	X	X		
2-Methoxyethanol, see Methyl cellosolve				
2-Methoxyethyl acetate (Ethylene glycol methyl ether acetate)		X		
4-Methoxyphenol		X		
Methyl acetate	X	X		
Methyl acetylene (propyne)	X	X		
Methyl acetylene-propadiene mixture (MAPP)	X	X		
Methyl acrylate	X	X		
Methylacrylonitrile		X		
Methylal (Dimethoxymethane)		X		
Methyl alcohol (methanol)	X	X		
Methylamine	X	X		
Methyl amyl alcohol, see Methyl isobutyl carbinol				
Methyl n-amyl ketone (2-Heptanone)	X	X		
N-Methyl aniline		X		
2-Methylaziridine				X
Methylazoxymethanol and its acetate				X

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Methyl bromide	X	X		
Methyl n-butyl ketone (2-Hexanone)	X	X		
Methyl cellosolve (2-Methoxyethanol)	X			
Methyl cellosolve acetate	X			
Methyl chloride	X	X		
Methyl chloromethyl ether	X			
Methyl chloroform	X	X		
Methyl 2-cyanoacrylate		X		
Methylcyclohexane	X	X		
Methylcyclohexanol		X		
o-Methylcyclohexanone	X	X		
Methylcyclopentadienyl manganese tricarbonyl, as Mn		X		
Methyl demeton		X		
Methylene bisphenyl isocyanate (MDI) (Diphenyl methane diisocyanate)	X	X		
Methylene chloride (Dichloromethane)	X	X		
4,4'-Methylene bis (2-chloroaniline) (MOCA)		X	X	X
Methylene bis (4-cyclohexylisocyanate)		X		
4,4'-Methylene bis (N,N-dimethyl) benzenamine			X	
4,4'-Methylene bis (2-methylaniline)				X
4,4-Methylene dianiline		X		
Methyl ethyl ketone (MEK) (2-Butanone)	X	X		
Methyl ethyl ketone peroxide		X		
Methyl formate	X	X		
5-Methyl-3-heptanone, see Ethyl amyl ketone				
Methyl hydrazine		X		
Methyl iodide	X	X		X
Methyl isoamyl ketone		X		
Methyl isobutyl carbinol (Methyl amyl alcohol)	X	X		
Methyl isobutyl ketone (MIBK) (Hexone)	X	X		
Methyl isocyanate	X	X		
Methyl isopropyl ketone		X		
Methyl mercaptan (Methanethiol)	X	X		
Methyl methacrylate	X	X		
Methyl methanesulfonate				X
2-Methyl-1-nitroanthraquinone (of uncertain purity)				X
N-Methyl-N'-nitro-N-nitrosoguanidine				X
Methyl parathion		X		
Methyl propyl ketone, see 2-Pentanone				
Methyl silicate		X		
a-Methyl styrene	X	X		
Methylthiouracil				X
Metronidazole				X
Mevinphos		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Michler's ketone			X	
Mirex			X	X
Mitomycin C				X
Molybdenum, as Mo Soluble compounds	X	X		
Insoluble compounds	X	X		
Monocrotaline				X
Monocrotophos		X		
Monomethyl aniline	X			
Monomethyl hydrazine	X			
Morpholine	X	X		
5-(Morpholinomethyl)-3[(5-nitrofurfurylidene)amino]-2-oxazolidinone				X
Mustard gas, see Nitrogen mustard				
Nafenopin				X
Naled (Dimethyl-1,2-dibromo-2-dichloroethyl phosphate)		X		
Naphtha (coal tar)	X			
Naphthalene	X	X		
alpha-Naphthylamine	X			X
B-Naphthylamine	X	X		X
Neon		X		
Nickel				
Metal	X	X	X	
Soluble compounds, as Ni	X	X	X	
Nickel carbonyl, as Ni	X	X		
Nickel subsulfide				X
Nickel sulfide roasting, fume & dust, as Ni		X		
Nicotine	X	X		
Niridazole				X
Nitrapyrin (2-Chloro-6-(trichloromethyl)pyridine)		X		
Nitric acid	X	X		
Nitric oxide	X	X		
Nitrilotriacetic acid			X	
5-Nitroacenaphthene				X
p-Nitroaniline	X	X		
5-Nitro-o-anisidine			X	
Nitrobenzene	X	X		
4-Nitrobiphenyl	X			
p-Nitrochlorobenzene	X	X		
4-Nitrodiphenyl		X		
Nitroethane	X	X		
Nitrofen			X	
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone				X
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide				X
Nitrogen dioxide	X	X		

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SUBSTANCE/PROCESS	OSHA	ACGIH	NTP	IARC
Nitrogen trifluoride	X	X		
Nitrogen mustard and Nitrogen mustard N-oxide				X
Nitroglycerin (NG)	X	X		
Nitromethane	X	X		
1-Nitropropane	X	X		
2-Nitropropane	X	X		X
N-Nitrosodi-n-butylamine			X	X
N-Nitrosodiethanolamine			X	X
N-Nitrosodiethylamine			X	X
N-Nitrosodimethylamine (dimethylnitrosoamine)	X	X	X	X
p-Nitrosodiphenylamine			X	
N-Nitrosodi-n-propylamine			X	X
N-Nitroso-N-ethylurea			X	X
N-Nitrosomethylethylamine				X
N-Nitroso-N-methylurea			X	X
N-Nitroso-N-methylurethane				X
N-Nitrosomethylvinylamine			X	X
N-Nitrosomorpholine			X	X
N-Nitrosonornicotine			X	X
N-Nitrosopiperidine			X	X
N-Nitrosopyrrolidine			X	X
N-Nitrososarcosine			X	X
Nitrotoluene	X	X		
Nitrotrichloromethane, see Chloropicrin				
Nonane		X		
Norethisterone				X
Octachloronaphthalene	X	X		
Octane	X	X		X
Oestradiol-17B				X
Oestrone				X
Oil mist, mineral	X	X		
Oil orange SS				X
Osmium tetroxide, as Os	X	X		
Oxalic acid	X	X		
Oxygen difluoride	X	X		
Oxymetholone			X	
Ozone	X	X		
Panfuran S (Dihydroxymethylfuratrizine)				X
Paraffin wax fume		X		
Paraquate, respirable sizes	X	X		
Parathion	X	X		
Particulate polycyclic aromatic hydrocarbons (PPAH), see Coal tar pitch volatiles				

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Pentaborane	X	X		
Pentachloronaphthalene	X	X		
Pentachlorophenol	X	X		
Pentaerythritol		X		
Pentane	X	X		
2-Pentanone (Methyl propyl ketone)	X	X		
Perchloroethylene		X		
Perchloromethyl mercaptan	X	X		
Perchloryl fluoride	X	X		
Petroleum distillates (naphtha)	X			
Phenacetin			X	X
Phenazopyradine and its hydrochloride			X	X
Phenol	X	X		
Phenothiazine		X		
Phenoxybenzamine and its hydrochloride				X
N-Phenyl-beta-naphthylamine		X		
p-Phenylene diamine	X	X		
Phenyl ether, vapor	X	X		
Phenyl ether-biphenyl mixture, vapor	X			
Phenylethylene, see Styrene, monomer				
Phenyl glycidyl ether (PGE)	X	X		
Phenylhydrazine	X	X		
Phenyl mercaptan		X		
Phenylphosphine		X		
Phenytoin and its sodium salt			X	
Phorate		X		
Phosdrin, see Mevinphos®				
Phosgene (carbonyl chloride)	X	X		
Phosphine	X	X		
Phosphoric acid	X	X		
Phosphorus (yellow)	X	X		
Phosphorus oxychloride		X		
Phosphorus pentachloride	X	X		
Phosphorus pentasulfide	X	X		
Phosphorus trichloride	X	X		
Phthalic anhydride	X	X		
m-Phthalodinitrile		X		
Picloram		X		
Picric acid	X	X		
Pindone		X		
Piperazine dihydrochloride		X		
2-Pivalyl-1, 3-indandione, see Pindone (Pival®)				
Plaster of Paris		X		
Platinum		X		
Metal		X		
Soluble salts, as Pt	X	X		

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	SOURCE*			
SUBSTANCE/PROCESS	OSHA	ACGIH	NTP	IARC
Polybrominated biphenyls (PBB's)			X	
Polychlorinated biphenyls (PCB's)	X	X	X	X
Polytetrafluoroethylene decomposition products		X		
Ponceau MX				X
Ponceau 3R				X
Potassium hydroxide		X		
Procarbazine and its hydrochloride			X	X
Progesterone				X
Propane	X	X		
1,3-Propane sultone		X		X
Propargyl alcohol		X		
B-Propiolactone	X	X	X	X
Propionic acid		X		
Propoxur		X		
n-Propyl acetate	X	X		
Propyl alcohol	X	X		
n-Propyl nitrate	X	X		
Propylene		X		
Propylene dichloride (1,2 Dichloropropane)	X	X		
Propylene glycol dinitrate		X		
Propylene glycol monomethyl ether		X		
Propyleneimine	X	X		
Propylene oxide (1,2 Epoxypropane)	X	X		
Propylthiouracil				X
Propyne, see Methyl acetylene				
Pyrethrum	X	X		
Pyridine	X	X		
Quinone (p-Benzoquinone)	X	X		
RDX, see Cyclonite				
Reserpine			X	
Resorcinol		X		
Rhodium				
Metal, fume and dusts, as Rh	X	X		
Soluble salts, as Rh	X	X		
Ronnel	X	X		
Rosin core solder pyrolysis products, as formaldehyde		X		
Rotenone (commercial)	X	X		
Rouge		X		
Rubber solvent (Naphtha)		X		
Saccharin, see Sodium saccharin				
Safrole			X	X

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
Selenium compounds, as Se	X	X		
Selenium hexafluoride, as Se	X	X		
Selenium Sulfide			X	
Sesone (Sodium 2,4-dichloro-phenoxyethyl sulfate)		X		
Silane, see Silicon tetrahydride				
Silica, Silicates - See MINERAL DUSTS, page 22				
Silicon		X		
Silicon carbide		X		
Silicon tetrahydride (Silane)		X		
Silver,				
as Ag Metal	X	X		
Soluble compounds	X	X		
Sintered calcium chromate				X
Sintered chromium trioxide				X
Sodium azide		X		
Sodium bisulfite		X		
Sodium 2, 4-dichloro-phenoxyethyl sulfate, see Sesone				
Sodium fluoroacetate (1080)	X	X		
Sodium hydroxide	X	X		
Sodium metabisulfite		X		
Sodium saccharin			X	X
Soots, tars and mineral oils				X
Starch		X		
Stibine	X	X		
Sterigmatocystin				X
Stoddard solvent	X	X		
Streptozotocin			X	X
Strontium chromate				X
Strychnine	X	X		
Styrene, monomer	X	X		
Subtilisins (Proteolytic enzymes as 100% pure crystalline enzyme)		X		
Sucrose		X		
Sulfallate			X	
Sulfotep		X		
Sulfur dioxide	X	X		
Sulfur hexafluoride	X	X		
Sulfuric acid	X	X		
Sulfur monochloride	X	X		
Sulfur pentafluoride	X	X		
Sulfur tetrafluoride		X		
Sulfuryl fluoride	X	X		
Systox, see Demeton®				

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NTP	IARC
2, 4, 5-T	X	X		
Tantalum	X	X		
TEDP, see Sulfotep				
Tellurium & compounds, as Te	X	X		
Tellurium hexafluoride, as Te	X	X		
Temephos		X		
TEPP	X	X		
Terphenyls	X	X		
Testosterone and its esters				X
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)			X	X
1,1,1,2-Tetrachloro-2, 2-difluoroethane	X	X		
1,1,2,2-Tetrachloro-1, 2-difluoroethane	X	X		
1,1,2,2-Tetrachloroethane	X	X		
Tetrachloroethylene, see Perchloroethylene				
Tetrachloromethane, see Carbon tetrachloride				
Tetrachloronaphthalene	X	X		
Tetraethyl lead, as Pb	X	X		
Tetrahydrofuran	X	X		
Tetramethyl lead, as Pb	X	X		
Tetramethyl succinonitrile	X	X		
Tetranitromethane	X	X		
Tetrasodium pyrophosphate		X		
Tetryl (2,4,6-trinitrophenyl-methylnitramine)	X	X		
Thallium Soluble compounds, as Tl	X	X		
Thioacetamide			X	X
4,4'-Thiobis (6-tert. butyl-m-cresol)		X		
4,4'-Thiodianiline				X
Thioglycollic acid		X		
Thiourea			X	X
Thiram	X	X		
Tin				
Metal		X		
Oxide & inorganic compounds, except SnO_4, as Sn		X		
Inorganic compounds, except oxides	X			
Organic compounds, as Sn	X	X		
Titanium dioxide, as Ti	X	X		
o-Tolidine		X		
Toluene (toluol)	X	X		
Toluene-2, 4-diisocyanate (TDI)	X	X		
o-Toluidine	X	X	X	X
o-Toluidine hydrochloride			X	
Toxaphene, see Chlorinated camphene				
Tributyl phosphate	X	X		
Trichloroacetic acid		X		

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HAZARDOUS CHEMICAL CLASSIFICATION GUIDE (FOR USE IN COMPLYING WITH OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200)

SUBSTANCE/PROCESS	SOURCE[a] OSHA	ACGIH	NTP	IARC
1,2,4-Trichlorobenzene		X		
1,1,1-Trichloroethane, see Methyl chloroform				
1,1,2-Trichloroethane	X	X		
Trichloroethylene	X	X		
Trichlorofluoromethane (fluorotrichloromethane)		X		
Trichloromethane, see Chloroform				
2,4,6-Trichlorophenol				X
Trichloronaphthalene	X	X		
Trichloronitromethane, see Chloropicrin				
2,4,6-Trichlorophenol			X	
1,2,3-Trichloropropane	X	X		
1,1,2-Trichloro-1,2,2-trifluoroethane	X	X		
Tricyclohexyltin hydroxide, see Cyhexatin				
Triethylamine	X	X		
Trifluorobromomethane		X		
Trifluoromonobromomethane	X			
Trimellitic anyhdride		X		
Trimethylamine		X		
Trimethyl benzene		X		
Trimethyl phosphite		X		
2,4,6-Trinitrophenol, see Picric acid				
2,4,6-Trinitrophenyl-methylnitramine, see Tetryl				
2,4,6-Trinitrotoluene (TNT)	X	X		
Triorthocresyl phosphate	X	X		
Triphenyl amine		X		
Triphenyl phosphate	X	X		
Tris (1-aziridinyl) phosphine sulfate (Thiotepa)				X
Tris (1-aziridinyl) phosphine sulfide			X	
Tris (2,3-dibromopropyl) phosphate			X	
Trypan Blue (commercial grade)				X
Tungsten, as W				X
Insoluble compounds		X		
Soluble compounds		X		
Turpentine	X	X		
Uracil Mustard				X
Uranium (natural), Soluble	X	X		
& Insoluble compounds, as U	X	X		
Urethane			X	X
Valeraldehyde		X		
Vanadium, as V_2O_5, respirable dust & fume	X	X		
Vegetable oil mists		X		
Vinyl acetate		X		
Vinyl benzene, see Styrene				
Vinyl bromide		X		

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SUBSTANCE/PROCESS	SOURCE* OSHA	ACGIH	NIP	IARC
Vinyl chloride (Chloroethylene)	X	X		X
Vinyl cyanide, see Acrylonitrile				
Vinyl cyclohexene dioxide		X		
Vinylidene chloride (1,1 Dichloroethylene)		X		
Vinyl toluene	X	X		
VM & P Naphtha		X		
Warfarin	X	X		
Welding fumes		X		
Wood dust (certain hard woods as beech & oak)		X		
Soft wood		X		
Xylene (o-, m-, p-isomers)(xylol)(Dimethyl benzene)	X	X		
m-Xylene a, a'-diamine		X		
Xylidine (Dimethyleminobenzene)	X	X		
Yttrium	X	X		
Zinc beryllium silicate				X
Zinc chloride fume	X	X		
Zinc chromate, as Cr		X		X
Zinc oxide				
Fume	X	X		
Dust		X		
Zinc stearate		X		
Zirconium compounds, as Zr	X	X		

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HAZARDOUS CHEMICAL CLASSIFICATION GUIDE (FOR USE IN COMPLYING WITH OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200)

SUBSTANCE/PROCESS	SOURCE*			
	OSHA	ACGIH	NTP	IARC
MINERAL DUSTS				
Silica, SiO2				
Crystalline	X	X		
Quartz	X	X		
Cristobalite	X	X		
Tridymite	X	X		
Silica, fused		X		
Tripoli		X		
Amorphous, including natural diatomaceous earth	X	X		
Silicates (1% quartz)				
Asbestos	X	X		
Graphite	X	X	X	X
Mica	X	X		
Mineral Wool Fiber	X	X		
Perlite		X		
Portland Cement		X		
Soapstone	X	X		
Talc (non-asbestos)	X	X		
Talc (fibrous)	X	X		
Tremolite (talc, fibrous)	X	X		
Coal Dust	X			
Inert (Nuisance) Dust	X	X		

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HAZARDOUS CHEMICAL CLASSIFICATION GUIDE

*Sources used in compling this listing are as follows:

OSHA: 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration

ACGIH: Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, 1983-1984 edition, American Conference of Governmental Industrial Hygienists

NTP: Annual Report on Carcinogens, third edition, National Toxicology Program, Public Health Service, U. S. Department of Health and Human Services

IARC: Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, 1982, International Agency for Research on Cancer, World Health Organization.

The OSHA Hazard Communication Standard, 29 CFR 1910.1200 (d)(3), states: "The chemical manufacturer, importer or employer (emphasis added) shall treat the (above) sources as establishing that the chemicals listed in them are hazardous."

This listing is considered a "baseline" for identification of chemicals designated as a "health hazard," and should not be considered all-inclusive. In addition to "health hazards," the OSHA definition of a "hazardous chemical" includes those representing "physical hazards" as well. A "physical hazard" is defined as any substance which is combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable or water-reactive. Any such substance must also be treated as a "hazardous chemical" for purposes of complying with the standard, regardless of whether it is included in this listing.

* Prepared by: Chemical Section Committee
National Safety Council
May, 1984

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WORLD HEALTH ORGANIZATION

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER

IARC MONOGRAPHS

ON THE

EVALUATION OF THE CARCINOGENIC RISK OF CHEMICALS TO HUMANS

Chemicals, Industrial Processes and Industries Associated with Cancer in Humans

IARC Monographs, Volumes 1 to 29

SUPPLEMENT 4

Report of an IARC *ad hoc* Working Group which met in Lyon, 8-12 February 1982 to advise the Director, IARC, on chemicals, industrial processes and industries that are carcinogenic for humans

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group of chemicals, industrial process or occupational exposure is genic to humans. This category includes exposures for which, at one dence of human carcinogenicity is almost '*sufficient*', as well as exposures other extreme, it is inadequate. To reflect this range, the category was er (*Group A*) and lower (*Group B*) degrees of evidence. Usually, category ed for exposures for which there was at least *limited evidence* of humans. The data from studies in experimental animals played an assigning studies to category 2, and particularly those in Group B; thus, of *sufficient evidence* in animals and inadequate data in humans usually lification of 2B.

. the Working Group considered that the known chemical properties of the results from short-term tests allowed its transfer from Group 3 to 3 to 2A

group of chemicals, industrial process or occupational exposure cannot its carcinogenicity to humans.

RESULTS AND CONCLUSIONS

ts of degrees of evidence for carcinogenicity to humans and in ials and for activity in short-term tests, as well as the summary nogenic risk to humans are given in Table 1.

Working Group concluded that the following 7 industrial processes and sures and 23 chemicals and groups of chemicals are causally cer in humans*.

es and occupational exposures:

nufacture
e manufacture and repair
upations)
ufacture
hot manufacture
process)

ry (certain occupations)
haematite mining
to radon)

include known human carcinogens such as tobacco smoke, betel quid and alcoholic not yet been covered in the *Monographs programme*

ther

Chemicals
4-Amin
Analges
Arsenic
Asbestc
Azathio
Benzen
Benzidi
N,N-Bis(
Bis(chlo
1,4-But
Certain
Chloram
Chromiu
Conjuga
Cycloph
Diethyls
Melphal
Methoxs
Mustard
2-Naphth
Soots, t
Treosulp
Vinyl chl

dustrial processes are

Group 2 Th
probably carcin

Group 2A

Acrylonit
Aflatoxin
Benzo(*a*)
Beryllium
Combine
Diethyl s
Dimethyl
Manufact
Nickel an
Nitrogen
Oxymeth
Phenacet
Procarba
ortho-Tol

nogenic polycyclic aromatic

* The compound
* Procarbazine, n
* Mineral oils (u
hydrocarbons

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Group 2B

Actinomycin D
Adriamycin
Amitrole
Auramine (technical grade)
Benzotrichloride
Bischloroethyl nitrosourea (BCNU)
Cadmium and cadmium compounds
Carbon tetrachloride
Chloramphenicol
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
Chloroform
Chlorophenols (occupational exposure to)*
Cisplatin
Dacarbazine
DDT
3,3'-Dichlorobenzidine
Dienoestrol
3,3'-Dimethoxybenzidine (*ortho*-Dianisidine)
Dimethylcarbamoyl chloride
1,4-Dioxane
Direct Black 38 (technical grade)
Direct Blue 6 (technical grade)
Direct Brown 95 (technical grade)
Epichlorohydrin
Ethinyloestradiol
Ethylene dibromide
Ethylene oxide
Ethylene thiourea
Formaldehyde (gas)
Hydrazine
Mestranol
Metronidazole
Norethisterone
Oestradiol-17β
Oestrone
Phenazopyridine
Phenytoin
Phenoxyacetic acid herbicides (occupational exposure to)*
Polychlorinated biphenyls
Progesterone
Propylthiouracil
Sequential oral contraceptives*
Tetrachlorodibenzo-*para*-dioxin (TCDD)
2,4,6-Trichlorophenol
Tris(aziridinyl)-*para*-benzoquinone (Triaziquone)
Tris(1-aziridinyl)phosphine sulphide (Thiotepa)
Uracil mustard

Group 3 The remaining 64 chemicals, groups of chemicals, industrial processes and occupational exposures could not be classified as to their carcinogenicity to humans

* The compound(s) responsible for the probable carcinogenic effect in humans cannot be specified

Table
proces:
animals

Chemic
or indu

Acrylon
Actinon
Adriam
Aflatox
Aldrin
4-Amin
Amitrol
Anaesth
Analges
phen
Phen
Aniline
Arsenic
comp
Asbesto
Auramir
Manufa
Azathio
Benzen
Benzidi
Benzidu
Direct
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beverages.

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Table 1. Summary evaluations of carcinogenic risk to humans from chemicals, industrial processes and industries* based on evidence for carcinogenicity to humans and to animals and for activity in short-term tests†

Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
Acrylonitrile	limited	sufficient	sufficient	2A
Actinomycin D	inadequate	limited	sufficient	2B
Adriamycin	inadequate	sufficient	sufficient	2B
Aflatoxins	limited	sufficient	sufficient	2A
Aldrin	inadequate	limited	inadequate	3
4-Aminobiphenyl	sufficient	sufficient	sufficient	1
Amitrole	inadequate	sufficient	inadequate	2B
Anaesthetics, volatile	inadequate	inadequate	inadequate	3
Analgesic mixtures containing phenacetin	sufficient	limited	no data	1
Phenacetin	limited	sufficient	limited	2A
Aniline	inadequate	limited	inadequate	3
Arsenic and certain arsenic compounds	sufficient	inadequate	limited	1
Asbestos	sufficient	sufficient	inadequate	1
Auramine (technical grade)	limited	limited	sufficient	2B
Manufacture of auramine	sufficient	-	-	1
Azathioprine	sufficient	limited	sufficient	1
Benzene	sufficient	limited	limited	1
Benzidine	sufficient	sufficient	sufficient	1
Benzidine-based dyes				
Direct Black 38 (technical grade)	inadequate	sufficient	inadequate	2B
Direct Blue 6 (technical grade)	inadequate	sufficient	no data	2B
Direct Brown 95 (technical grade)	inadequate	limited	no data	2B
Beryllium and beryllium compounds	limited	sufficient	inadequate	2A
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)	sufficient	limited	limited	1
Bischloroethyl nitrosourea (BCNU)	inadequate	sufficient	sufficient	2B
Bis(chloromethyl)ether and technical-grade chloromethylmethyl ether	sufficient	sufficient	limited	1

* In *IARC Monographs* 1-29, for which data in humans were available

† This table does not include known human carcinogens such as tobacco smoke, betel quid and alcohol beverages, since they have not yet been considered in the *IARC Monographs*

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Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
Bleomycins	inadequate	inadequate	sufficient	3
1,4-Butanediol dimethanesulphonate (Myleran)	sufficient	limited	sufficient	1
Cadmium and cadmium compounds	limited	sufficient	inadequate	2B
Carbon tetrachloride	inadequate	sufficient	inadequate	2B
Certain combined chemotherapy for lymphomas (including MOPP)	sufficient	-	inadequate	1
Chlorambucil	sufficient	sufficient	sufficient	1
Chloramphenicol	limited	inadequate	inadequate	2B
Chlordane/Heptachlor	inadequate	limited	inadequate	3
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	inadequate	sufficient	sufficient	2B
Chlorinated toluenes (production of):				
Benzyl chloride	inadequate	limited	sufficient	3
Benzoyl chloride	inadequate	inadequate	inadequate	3
Benzal chloride	inadequate	limited	limited	3
Benzotrichloride	inadequate	sufficient	limited	2B
Chloroform	inadequate	sufficient	inadequate	2B
Chlorophenols (occupational exposure to)	limited	-	-	2B
Chloroprene	inadequate	inadequate	sufficient	3
Chromium and certain chromium compounds	sufficient	sufficient	sufficient (Cr VI) inadequate (Cr III)	1
Cisplatin	inadequate	limited	sufficient	2B
Clofibrate	inadequate	limited	inadequate	3
Clomiphene	inadequate	inadequate	no data	3
Cyclamates	inadequate	limited	inadequate	3
Cyclophosphamide	sufficient	sufficient	sufficient	1
2,4-D and esters (See also Phenoxyacetic acid herbicides, occupational exposure to)	inadequate	inadequate	inadequate	3
Dacarbazine	inadequate	sufficient	limited	2B
Dapsone	inadequate	limited	inadequate	3
DDT	inadequate	sufficient	inadequate	2B
ortho-Dichlorobenzene and *para*-Dichlorobenzene	inadequate	inadequate	inadequate	3

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Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
3,3'-Dichlorobenzidine	inadequate	sufficient	sufficient	2B
Dichloromethane	inadequate	inadequate	limited	3
Dieldrin	inadequate	limited	inadequate	3
Diethyl sulphate	limited	sufficient	sufficient	2A
3,3'-Dimethoxybenzidine (*ortho*-Dianisidine)	inadequate	sufficient	limited	2B
Dimethylcarbamoyl chloride	inadequate	sufficient	sufficient	2B
Dimethyl sulphate	inadequate	sufficient	sufficient	2A
1,4-Dioxane	inadequate	sufficient	inadequate	2B
Epichlorohydrin	inadequate	sufficient	sufficient	2B
Ethylene dibromide	inadequate	sufficient	sufficient	2B
Ethylene oxide	inadequate	limited	sufficient	2B
Ethylene thiourea	inadequate	sufficient	limited	2B
5-Fluorouracil	inadequate	inadequate	limited	3
Formaldehyde (gas)	inadequate	sufficient	sufficient	2B
Hexachlorocyclohexane	inadequate	limited	inadequate	3
Hydralazine	inadequate	limited	sufficient	3
Hydrazine	inadequate	sufficient	sufficient	2B
Industries				
Boot and shoe manufacture and repair (certain occupations)	sufficient	-	-	1
Carpentry and joinery (certain exposures)	inadequate	-	-	3
Furniture manufacture	sufficient	-	-	1
Leather goods manufacture	inadequate	-	-	3
Leather tanning	inadequate	-	-	3
Lumber and sawmill industry	inadequate	-	-	3
Pulp and paper manufacture (certain exposures)	inadequate	-	-	3
Rubber industry (certain occupations)	sufficient	-	-	1
Iron dextran complex	inadequate	sufficient	inadequate	3
Isonicotinic acid hydrazide	inadequate	limited	limited	3
Lead and lead compounds	inadequate	sufficient (for some salts)	inadequate	3
Manufacture of isopropyl alcohol (strong-acid process)	sufficient	-	-	1
Isopropyl oils	inadequate	inadequate	no data	3
Manufacture of magenta	limited	-	-	2A
Magenta (technical grade)	inadequate	inadequate	inadequate	3
Melphalan	sufficient	sufficient	sufficient	1
6-Mercaptopurine	inadequate	inadequate	sufficient	3

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Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
Methotrexate	inadequate	inadequate	sufficient	3
Methoxsalen with ultraviolet A therapy (PUVA)	sufficient	sufficient	sufficient	1
Metronidazole	inadequate	sufficient	limited	2B
Mustard gas	sufficient	limited	sufficient	1
1-Naphthylamine	inadequate	inadequate	sufficient	3
2-Naphthylamine	sufficient	sufficient	sufficient	1
Nickel refining	sufficient	-	-	1
Nickel and certain nickel compounds	limited	sufficient	inadequate	2A
Nitrogen mustard (See also Certain combined chemotherapy for lymphomas)	inadequate	sufficient	sufficient	2A
Oestrogens and progestins				
Combined oral contraceptives	limited*	-	inadequate	2A
Sequential oral contraceptives	limited	-	-	2B
Other oestrogen-progestin combinations	inadequate	-	-	3
Conjugated oestrogens	sufficient	inadequate	inadequate	1
Oestrogens				
Dienoestrol	limited	inadequate	inadequate	2B
Diethylstilboestrol	sufficient	sufficient	inadequate	1
Ethinyloestradiol	inadequate	sufficient	inadequate	2B
Mestranol	inadequate	sufficient	inadequate	2B
Oestradiol-17β	inadequate	sufficient	inadequate	2B
Oestrone	inadequate	sufficient	inadequate	2B
Progestins:				
Chlormadinone acetate	inadequate	limited	inadequate	3
Dimethisterone	inadequate	inadequate	inadequate	3
Ethynodiol diacetate	inadequate	limited	inadequate	3
17α-Hydroxyprogesterone caproate	inadequate	inadequate	no data	3
Lynoestrenol	inadequate	inadequate	inadequate	3
Medroxyprogesterone acetate	inadequate	limited	inadequate	3
Megestrol acetate	inadequate	limited	inadequate	3
Norethisterone	inadequate	sufficient	inadequate	2B
Norethynodrel	inadequate	limited	inadequate	3
Norgestrel	inadequate	inadequate	no data	3
Progesterone	inadequate	sufficient	inadequate	2B

* Sufficient for liver adenomas

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Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
Oxymetholone	limited	no data	no data	2A
Pentachlorophenol (See also Chlorophenols, occupational exposure to)	inadequate	inadequate	inadequate	3
Phenazopyridine	inadequate	sufficient	no data	2B
Phenelzine	inadequate	limited	inadequate	3
Phenobarbital	inadequate	limited	inadequate	3
Phenoxyacetic acid herbicides (occupational exposure to)	limited	-	-	2B
Phenylbutazone	inadequate	no data	inadequate	3
N-Phenyl-2-naphthylamine	inadequate	inadequate	inadequate	3
Phenytoin	limited	limited	inadequate	2B
Polychlorinated biphenyls	inadequate	sufficient	inadequate	2B
Prednisone (See also Certain combined chemotherapy for lymphomas)	inadequate	inadequate	inadequate	3
Procarbazine (See also Certain combined chemotherapy for lymphomas)	inadequate	sufficient	sufficient	2A
Propylthiouracil	inadequate	sufficient	no data	2B
Reserpine	inadequate	limited	inadequate	3
Saccharin	inadequate	limited	inadequate	3
Soots, tars and oils	sufficient	sufficient	-	1
Benzo[*a*]pyrene	inadequate	sufficient	sufficient	2A
Spironolactone	inadequate	limited	no data	3
Styrene	inadequate	limited	sufficient	3
Styrene oxide	inadequate	limited	sufficient	3
Sulfafurazole	inadequate	inadequate	inadequate	3
Sulfamethoxazole	inadequate	limited	inadequate	3
2,4,5-T and esters (See also Phenoxyacetic acid herbicides, occupational exposure to)	inadequate	inadequate	inadequate	3
Tetrachlorodibenzo-*para*-dioxin (TCDD)	inadequate	sufficient	inadequate	2B
Tetrachloroethylene	inadequate	limited	inadequate	3
ortho-Toluidine	inadequate	sufficient	sufficient	2A
Treosulphan	sufficient	no data	inadequate	1
Trichloroethylene	inadequate	limited	inadequate	3
2,4,5-Trichlorophenol (See also Chlorophenols, occupational exposure to)	inadequate	inadequate	no data	3
2,4,6-Trichlorophenol (See also Chlorophenols, occupational exposure to)	inadequate	sufficient	no data	2B

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Chemical, process or industry	Evidence for carcinogenicity in humans	Evidence for carcinogenicity in animals	Evidence for activity in short-term tests	Summary evaluation of carcinogenic risk to humans
Tris(aziridinyl)-*para*-benzoquone (Triaziquone)	inadequate	limited	sufficient	2B
Tris(1-aziridinyl)phosphine sulphide (Thiotepa)	inadequate	sufficient	sufficient	2B
Underground haematite mining (with exposure to radon)	sufficient	-	-	1
Haematite	inadequate	inadequate	inadequate	3
Uracil mustard	inadequate	sufficient	sufficient	2B
Vinblastine	inadequate	inadequate	inadequate	3
Vincristine (See also Certain combined chemotherapy for lymphomas)	inadequate	inadequate	inadequate	3
Vinyl chloride	sufficient	sufficient	sufficient	1
Vinylidene chloride	inadequate	limited	sufficient	3

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TABLE 43

CHEMICALS, SUBSTANCES AND MANUFACTURING PROCESSES INCLUDED IN THE THIRD ANNUAL REPORT ON CARCINOGENS

1. 2-Acetylaminofluorene
2. Acrylonitrile
3. Aflatoxins
4. 2-Aminoanthraquinone
5. 4-Aminobiphenyl
6. 1-Amino-2-Methylanthraquinone
7. Amitrole
8. o-Anisidine Hydrochloride
9. Aramite
10. Arsenic and certain arsenic compounds
11. Asbestos
12. Auramine, Manufacture of
13. Benz(a)anthracene
14. Benzene
15. Benzidine
16. Benzo(b)fluoranthene
17. Benzo(a)pyrene
18. Beryllium and Certain Beryllium Compounds
19. N,N-bis(2-chloroethyl)-2-naphthylamine
20. Bis(chloromethyl)ether and technical grade chloromethylmethyl ether
21. Cadmium and Certain Cadmium Compounds
22. Carbon Tetrachloride
23. Chlorambucil
24. Chloroform
25. Chromium and certain chromium compounds
26. Coke oven emissions
27. p-Cresidine
28. Cupferron
29. Cycasin
30. Cyclophosphamide
31. 2,4-Diaminoanisole Sulfate
32. 2,4-Diaminotoluene
33. Dibenz(a,h)acridine
34. Dibenz(a,j)acridine
35. Dibenz(a,h)anthracene
36. 7H-Dibenzo(c,g)carbazole
37. Dibenzo(a,h)pyrene
38. Dibenzo(a,i)pyrene
39. 1,2-Dibromo-3-chloropropane
40. 1,2-Dibromoethane
41. Dichlorobenzidine
42. 1,2-Dichloroethane
43. Diepoxybutane
44. Di(2-ethylhexyl)phthalate

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TABLE 43 (Continued)

45. Diethylstilboestrol
46. 3,3'-Dimethoxybenzidine
47. 3,3'-Dimethylbenzidine
48. 4-Dimethylaminoazobenzene
49. Dimethylcarbamoyl Chloride
50. Dimethyl Sulfate
51. 1,4-Dioxane
52. Direct Black 38
53. Direct Blue 6
54. Ethylene Thiourea
55. Formaldehyde
56. Haematite underground mining
57. Hexachlorobenzene
58. Hydrazine and Hydrazine Sulfate
59. Hydrazobenzene
60. Indeno(1,2,3-cd)pyrene
61. Iron Dextran
62. Isopropyl Alcohol
63. Kepone
64. Lead Acetate and Lead Phosphate
65. Lindane and Other Hexachlorocyclohexane Isomers
66. Melphalan
67. 4,4'-Methylene bis(2-chloroaniline)
68. 4,4'-Methylene bis(N,N-dimethyl) benzenamine
69. Michler's Ketone
70. Mirex
71. Mustard gas
72. 2-Naphthylamine
73. Nickel refining
74. Nitrilotriacetic acid
75. Nitrofen
76. 5-Nitro-o-anisidine
77. N-Nitrosodi-n-butylamine
78. N-Nitrosodiethanolamine
79. N-Nitrosodiethylamine
80. N-Nitrosodimethylamine
81. p-Nitrosodiphenylamine
82. N-Nitrosodi-n-propylamine
83. N-Nitroso-N-ethylurea
84. N-Nitroso-N-methylurea
85. N-Nitrosomethylvinylamine
86. N-Nitrosomorpholine
87. N-Nitrosonornicotine
88. N-Nitrosopiperidine
89. N-Nitrosopyrrolidine
90. N-Nitrososarcosine
91. Oxymetholone
92. Phenacetin

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TABLE 43 (Continued)

93. Phenazopyridine hydrochloride
94. Phenytoin
95. Polybrominated Biphenyls
96. Polychlorinated Biphenyls
97. Procarbazine and Procarbazine Hydrochloride
98. β-Propiolactone
99. Reserpine
100. Saccharin
101. Safrole
102. Selenium Sulfide
103. Soots, tars and mineral oils
104. Streptozotocin
105. Sulfallate
106. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
107. Thioacetamide
108. Thiourea
109. Thorium dioxide
110. o-Toluidine Hydrochloride
111. Toxaphene
112. 2,4,6-Trichlorophenol
113. Tris(1-aziridiny`)phosphine sulfide
114. Tris(2,3-dibromopropyl)phosphate
115. Urethane
116. Vinyl chloride

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GLOSSARY OF COMMON MSDS TERMS

-------- A --------

Absolute — A chemical substance that is not mixed; pure. An example is absolute alcohol, which is ethyl alcohol containing not more than one percent by weight of water.

Acid — Any chemical which undergoes dissociation in water with the formation of hydrogen ions. Acids have a sour taste and may cause severe skin burns. Acids turn litmus paper red and have pH values of 0 to 6.

Acute Effect — An adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis. Examples include dizziness, nausea, skin rashes, inflammation, tearing of the eyes, unconsciousness, and even death.

Acute Toxicity — The adverse (acute) effects resulting from a single dose of or exposure to a substance. Ordinarily used to denote effects in experimental animals.

ACGIH — American Conference of Governmental Industrial Hygienists; an organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limit for hundreds of chemical substances and physical agents. See **TLV.**

Aerosol — A fine aerial suspension of particles sufficiently small in size to confer some degree of stability from sedimentation, for example, a smoke or fog.

Air Line Respirator — A respirator that is connected to a compressed breathing air source by a hose of small inside diameter. The air is delivered continuously or intermittently in a sufficient volume to meet the wearer's breathing requirements.

Air Purifying Respirator — A respirator that uses chemicals to remove specific gases and vapors from the air or that uses a mechanical filter to remove particulate matter. An air purifying respirator must only be used when there is sufficient oxygen to sustain life and the air contaminant level is below the concentration limits of the device.

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Alkali	Any chemical substance which forms soluble soaps with fatty acids. Alkalis are also referred to as bases. They may cause severe burns to the skin. Alkalis turn litmus paper blue and have pH values from 8 to 14.
Allergic Reaction	An abnormal physiological response to a chemical or physical stimuli by a sensitive person.
Anesthetic	A chemical that causes a total or partial loss of sensation. Overexposure to anesthetics can cause impaired judgment, dizziness, drowsiness, headache, unconsciousness, and even death. Examples include alcohol, paint remover, and degreasers.
ANSI	American National Standards Institute; a privately funded, voluntary membership organization that identifies industrial and public needs for national concensus standards and coordinates development of such standards. Many ANSI standards relate to safe design/performance of equipment, such as safety shoes, eyeglasses, smoke detectors, fire pumps and household appliances; and safe practices or procedures, such as noise measurement, testing of fire extinguishers and flame arrestors, industrial lighting practices, and the use of abrasive wheels.
Antidote	A remedy to relieve, prevent, or counteract the effects of a poison.
API	American Petroleum Institute; voluntary membership organization of the petroleum industry. Among its services, API assists member committees in developing, by the concensus process, and publishing recommended practices for drilling and well servicing, storage tank installation, tank cleaning, piping and fittings, other industry-related design, installation and operating practices. It also funds and publishes basic reference books and manuals, for example, "Industrial Hygiene Monitoring Manual for Petroleum Refineries and Selected Petrochemical Operations".
Appearance	A description of a substance at normal room temperature and normal atmospheric conditions. Appearance includes the color, size, and consistency of a material.
Aquatic Toxicity	The adverse effects to marine life that result from being exposed to a toxic substance.

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Asphyxiant

A vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21%) to dangerous levels (16% or lower). Asphyxiation is one of the principal potential hazards of working in confined spaces. In addition, some chemicals like carbon monoxide function as chemical asphyxiants by reducing the blood's ability to carry oxygen.

ASTM

American Society for Testing and Materials; voluntary membership organization with members from broad spectrum of individuals, agencies, and industries concerned with materials. As the world's largest source of voluntary concensus standards for materials, products, systems and services, ASTM is a resource for sampling and testing methods, health and safety aspects of materials, safe performance guidelines, and effects of physical and biological agents and chemicals.

Atmosphere Supplying Respirator

A respirator that provides breathing air from a source independent of the surrounding atmosphere. There are two types: air line and self-contained breathing apparatus.

Auto-Ignition Temperature

The temperature to which a closed, or nearly closed container must be heated in order that the flammable liquid, when introduced into the container, will ignite spontaneously or burn.

-------- B --------

Base

See **Alkali.**

Biodegradable

Capable of being broken down into innocuous products by the action of living things.

Boiling Point

The temperature at which a liquid changes to a vapor state, at a given pressure; usually expressed in degrees Fahrenheit at sea level pressure (760mmHg, or one atmosphere). For mixtures, the initial boiling point or the boiling range may be given. Flammable materials with low boiling points generally present special fire hazards. Some approximate boiling points:

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Propane	-44°F
Anhydrous Ammonia	-28°F
Butane	31°F
Gasoline	100°F
Allyl Chloride	113°F
Ethylene Glycol	387°F

BOM — Bureau of Mines of the U.S. Department of Interior. BuMines began approving air breathing apparatus in 1918, later added all types of respirators. BOM's respirator testing/approval activities have been discontinued. BOM-approved Type 14F gas masks are still acceptable; all other BOM approvals have expired or been replaced by NIOSH approvals.

Bonding — The interconnecting of two objects by means of a clamp and bare wire. Its purpose is to equalize the electrical potential between the objects to prevent a static discharge when transferring a flammable liquid from one container to another. The conductive path is provided by clamps which make contact with the charged object and a low resistance flexible cable which allows the charge to equalize. See **Grounding.**

Bulk Density — Mass of powdered or granulated solid material per unit of volume.

BuMines — See **BOM**

-------- C --------

C — Ceiling limit; ACGIH terminology. See **TLV.**

CAA — See **Clean Air Act.**

Carcinogen — A substance or agent that can cause a growth of abnormal tissue or tumors in humans or animals. A material identified as an animal carcinogen does not necessarily cause cancer in humans. Examples of human carcinogens include coal tar, which can cause skin cancer, and vinyl chloride, which can cause liver cancer.

C.A.S. — Chemical Abstracts Service; A Columbus, Ohio organization which indexes information published in "Chemical Abstracts" by the American Chemical Society and provides index guides by which information about particular substances may be located in the "Abstracts" when needed. "C.A.S. Numbers" identify specific chemicals.

Caustic — See **Alkali.**

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cc	Cubic centimeter; a volume measurement in the metric system, equal in capacity to one milliliter (ml) - approximately twenty (20) drops. There are 16.4 cc in one cubic inch.
Ceiling	See C.
Central Nervous System	The brain and spinal cord. These organs supervise and coordinate the activity of the entire nervous system. Sensory impulses are transmitted into the central nervous system, and motor impulses are transmitted out.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The Act requires that the Coast Guard National Response Center be notified in the event of a hazardous substance release. The Act also provides for a fund (the Superfund) to be used for the cleanup of abandoned hazardous waste disposal sites.
CFR	Code of Federal Regulations. A collection of the regulations that have been promulgated under U. S. law.
Chemical Cartridge Respirator	A respirator that uses various chemical substances to purify inhaled air of certain gases and vapors. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV.
Chemical Family	A group of single elements or compounds with a common general name. Example: acetone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK) are of the "ketone" family; acrolein, furfural, and acetaldehyde are of the "aldehyde" family.
Chemical Name	The scientific designation of a chemical in accordance with the nomenclature system as developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature.
Chemical Structure	The arrangement within the molecule of atoms and their chemical bonds.
CHEMTREC	Chemical Transportation Emergency Center; a national center established by the Chemical Manufacturers Association (CMA) in Washington, DC in 1970, to relay pertinent emergency information concerning specific chemicals on request.

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	CHEMTREC has a 24-hour toll free telephone number (800-424-9300), intended primarily for use by those who respond to chemical transportation emergencies.
Chronic Effect	An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which recur frequently. Examples include cancer and irreversible damage to certain organs.
Chronic Exposure	Long-term contact with a substance.
Chronic Toxicity	Adverse (chronic) effects resulting from repeated doses of or exposures to a substance over a relatively prolonged period of time. Ordinarily used to denote effects in experimental animals.
Clean Air Act	Federal law enacted to regulate/reduce air pollution. Administered by EPA.
Clean Water Act	Federal law enacted to regulate/reduce water pollution. Administered by EPA.
CMA	Chemical Manufacturers Association. See **CHEMTREC.**
COC	Cleveland Open Cup; a flash point test method.
Code of Federal Regulations	See **CFR.**
Combustible	Able to catch on fire and burn.
Combustible Liquid	Any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the total volume of which make up ninety-nine (99%) or more of the total volume of the mixture.
Common Name	Any designation or identification such as code name, code number, trade name, brand name, or generic name used to identify a chemical other than by its chemical name.
Compressed Gas	(1) Any gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or (2) a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or (3) a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

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Concentration	The relative amount of a substance when combined or mixed with other substances. Examples: 2 ppm hydrogen sulfide in air, or a 50 per cent caustic solution.
Conditions to Avoid	Conditions encountered during handling or storage which could cause a substance to become unstable.
Confined Space	Any area which has limited openings for entry and exit that would make escape difficult in an emergency, has a lack of ventilation, contains known and potential hazards, and is not intended nor designated for continuous human occupancy.
Conjunctivitis	Inflammation of the conjunctiva, the delicate membrane that lines the eyelids and covers the eyeballs.
Corrosive	As defined by DOT, a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or - in the case of leakage from its packaging - a liquid that has a severe corrosion rate on steel. Two common examples are caustic soda and sulfuric acid.
CPSC	Consumer Products Safety Commission; Federal agency with responsibility for regulating hazardous materials when they appear in consumer goods. For CPSC purposes, hazards are defined in the Hazardous Substances Act and the Poison Prevention Packaging Act of 1970.
Cutaneous Toxicity	See **Dermal Toxicity.**
CWA	See **Clean Water Act.**

-------- D --------

Dangerous When Wet	See **Water-Reactive.**
Decomposition	Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into parts or elements or simpler compounds.
Density	The mass (weight) per unit volume of a substance. For example, lead is much more dense than aluminum.

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Depressant	A substance that reduces a bodily functional activity or an instinctive desire, such as appetite.
Dermal	Used on or applied to the skin.
Dermal Toxicity	Adverse effects resulting from skin exposure to a substance. Ordinarily used to denote effects in experimental animals.
Dermatitis	Inflammation of the skin.
DHHS	U.S. Department of Health and Human Services; created in 1980 to replace the Department of Health, Education, and Welfare (DHEW) as "parent" for NIOSH, Public Health Service, and other agencies related to health and safety.
Dike	A barrier constructed to control or confine hazardous substances and prevent them from entering sewers, ditches, streams, or other flowing waters.
Dilution Ventilation	Air flow designed to dilute contaminants to acceptable levels. Also referred to as general ventilation or exhaust. See **General Exhaust.**
DOL	U.S. Department of Labor; includes the Occupational Safety and Health Administration (OSHA).
DOT	U.S. Department of Transportation; regulates transportation of chemicals and other substances, to aid in the protection of the public as well as fire, law enforcement, and other emergency response personnel, particularly when transportation incidents occur involving hazardous materials.
DOT Hazard Class	DOT requires that hazardous materials offered for shipment be labeled with the proper DOT hazard class. These classes include corrosive, flammable liquid, organic peroxide, ORM-E, poison B, etc. The DOT hazard class may not adequately describe all the hazard properties of the material. A chart of the various DOT hazard classes can be found on the next page.
Dry Chemical	A powdered fire extinguishing agent usually composed of sodium bicarbonate, potassium bicarbonate, etc.

-------- E --------

Edema	An abnormal accumulation of clear watery fluid in the tissues.

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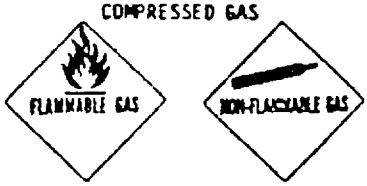
DOT HAZARD CLASSES

EXPLOSIVES



Black on orange

COMPRESSED GAS



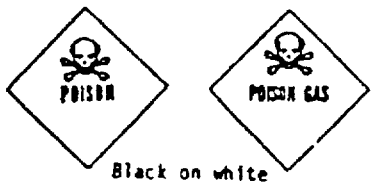
Black on red Black on green

FLAMMABLE SOLID



Black letters on red & white stripe

POISONOUS MATERIAL



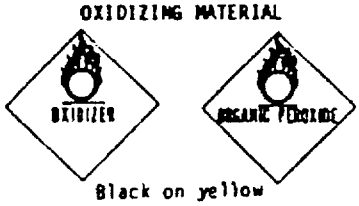
Black on white

CORROSIVE MATERIAL



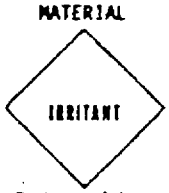
Black on white

OXIDIZING MATERIAL



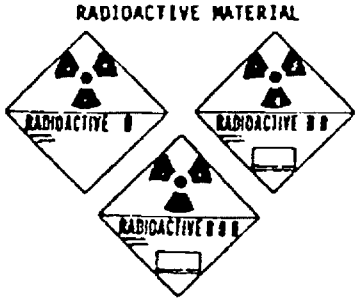
Black on yellow

IRRITATING MATERIAL



Red on white

RADIOACTIVE MATERIAL



Black on yellow (top)
Black on white (bottom)

FLAMMABLE LIQUID



Black on red

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Environmental Toxicity	Information obtained as a result of conducting environmental testing designed to study the effects on aquatic and plant life.
EPA	U.S. Environmental Protection Agency; Federal agency with environmental protection regulatory and enforcement authority. Administers Clean Air Act, Clean Water Act, FIFRA, RCRA, TSCA, other Federal environmental laws.
Epidemiology	The science which deals with the study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (as by age, sex, or occupation) may provide information about the causes of the disease.
Evaporation Rate	The rate at which a particular material will vaporize (evaporate) when compared to the rate of vaporization of a known material. The evaporation rate can be useful in evaluating the health and fire hazards of a material. The known material is usually ethyl ether with a vaporization rate designated as 1.0. Vaporization rates of other solvents or materials are then classified as: FAST evaporating if greater then 3.0. Examples: Methyl Ethyl Ketone (MEK) = 3.8, Acetone = 5.6, Hexane = 8.3. MEDIUM evaporating if 0.8 to 3.0. Examples: 190 proof (95%) Ethyl Alcohol = 1.4, VM&P Naphtha = 1.4, MIBK = 1.6. SLOW evaporating if less than 0.8. Examples: Xylene = 0.6, Isobutyl Alcohol = 0.6, Normal Butyl Alcohol = 0.4, Water = 0.3, Mineral Spirits = 0.1.
Exothermic Polymerization	A polymerization reaction that involves the production of heat.
Explosive	A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

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Exposure	Being actually subjected to a hazardous chemical in the course of employment through any route of entry (inhalation, ingestion, skin contact, or absorption, etc.). The Federal hazard communication standard also includes both accidental and possible exposures in its definition of exposure.
Extinguishing Media	The fire fighting substance to be used to control a material in the event of a fire. It is usually named by its generic name, such as fog, foam, water, etc.
Eye Protection	Recommended safety glasses, chemical splash goggles, face shields, etc. to be utilized when handling a hazardous material.

-------- F --------

F	Fahrenheit; a scale for measuring temperature. On the Fahrenheit scale water boils at 212° and freezes at 32°.
f/cc	Fibers per cubic centimeter of air. The concentration of asbestos in air is reported as fibers of asbestos per cubic centimeter of air.
FDA	The U.S. Food and Drug Administration; under the provisions of the Federal Food, Drug and Cosmetic Act, the FDA establishes requirements for the labeling of foods and drugs to protect consumers from misbranded, unwholesome, ineffective, and hazardous products. FDA also regulates materials for food contact service and the conditions under which such materials are approved.
Federal Register	See **FR.**
Fibrosis	An abnormal thickening of fibrous connective tissue, usually in the lungs.
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act; regulations administered by EPA under this Act require that certain useful poisons, such as chemical pesticides, sold to the public contain labels that carry health hazard warnings to protect users.

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First Aid	Emergency measures to be taken when a person is suffering from overexposure to a hazardous material, before regular medical help can be obtained.
Flammability Limits	The range of gas or vapor concentration in the air that may ignite or explode if an ignition source is present.
Flammable Aerosol	An aerosol that, when tested by the method described in 16 CFR, 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.
Flammable Gas	(1) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen percent (13%) by volume or less; or (2) a gas that at ambient temperature and pressure, forms a range of flammable mixtures with air, wider that twelve percent (12%) by volume, regardless of the lower limit.
Flammable Liquid	Any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up ninety-nine percent (99%) or more of the total volume of the mixture.
Flammable Solid	A solid, other than a blasting agent or explosive, as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard.
Flashback	Occurs when flame from a torch burns back into the tip, the torch, or the hose. It is often accompanied by a hissing or squealing sound with a smoky or sharp-pointed flame.
Flash Ignition	See **Flash Point.**
Flash Point	The temperature at which a liquid will give off enough flammable vapor to ignite if an ignition source is present. There are several flash point test methods, and flash points may vary for the same material depending on the method used, so the test method is indicated when the flash point is given (150° PMCC, 200° TCC, etc.).

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Formula	The conventional scientific designation for a material (water is H_2O, sulfuric acid is H_2SO_4, sulfur dioxide is SO_2, etc.).
FR	Federal Register. A daily publication of Federal department regulations that are promulgated under a particular law.
Fume	Airborne dispersion consisting of minute solid particles arising from the heating of a solid body, such as lead. This heating is often accompanied by a chemical reaction, such as oxidation.

-------- G --------

General Exhaust	A system for exhausting air containing contaminants from a general work area, usually accomplished via dilution.
g	Gram; a metric unit of mass weight. One ounce U.S. is about 28 grams and one pound is 454 grams. One teaspoon of sugar weighs about 8 grams.
g/kg	Grams per kilogram; an expression of dose used in oral and dermal toxicology testing to indicate the grams of substance dosed per kilogram of animal body weight. Also see **kg**.
Generic Name	A non-propriatary name for a material.
Gram	See **g**.
Grounding	The procedure used to carry an electrical charge to ground through a conductive path. A typical ground may be connected directly to a conductive water pipe or to a grounding bus and ground rod. See **Bonding**.

-------- H --------

Hand Protection	Specific type of gloves or other hand protection required to prevent harmful exposure to hazardous materials.
Hazardous Material	Any chemical which is a physical hazard or a health hazard.

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Hazardous Decomposition Products	Any hazardous materials that may be produced in dangerous amounts if the material reacts with other agents, burns, or is exposed to other processes, such as welding. Examples of hazardous decomposition products formed when certain materials are heated include carbon monoxide and carbon dioxide.
Hazardous Ingredients	The hazardous substances that make up a mixture.
Hazardous Polymerization	Polymerization is a chemical reaction in which one or more small molecules combine to form larger molecules. A hazardous polymerization is such a reaction which takes place at a rate which releases large amounts of energy. If hazardous polymerization can occur with a given material, the MSDS usually will list conditions which could start the reaction; and since the material usually contains a polymerization inhibitor, the expected time period before the inhibitor is used up.
Health Hazard	A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.
Hematopoietic System	The blood forming mechanism of the human body.
Hepatotoxin	A substance that causes injury to the liver.
	--------I--------
IARC	International Agency for Research on Cancer. IARC publishes Monographs, a listing of potential carcinogens
Ignitable	Capable of being set afire.
Impervious	A material that does not allow another substance to pass through or penetrate it.

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Incompatible	Materials which could cause dangerous reactions from direct contact with one another are described as incompatible.
Ingestion	The taking in of a substance through the mouth.
Inhalation	The breathing in of a substance in the form of a gas, vapor, fume, mist, or dust.
Inhibitor	A chemical which is added to another substance to prevent an unwanted chemical change from occurring.
Insoluble	Incapable of being dissolved in a liquid.
Irritant	A substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, or respiratory system. The contact may be a single exposure or multiple exposures. Some primary irritants: chromic acid, nitric acid, sodium hydroxide, calcium chloride, amines, metallic salts, chlorinated hydrocarbons, ketones, alcohols.
Irritating	An irritating material, as defined by DOT, is a liquid or solid substance which, upon contact with fire or when exposed to air, gives off dangerous or intensely irritating fumes (not including poisonous materials). See **Poison, Class A** and **Poison, Class B.**

-------- K --------

kg	Kilogram; a metric unit of weight, about 2.2 U.S. pounds. Also see **g/kg, g,** and **mg.**

-------- L --------

L	Liter; a metric unit of capacity. A liter is about the same as one (1) quart.
Lacrimation	Secretion and discharge of tears.
LC	Lethal concentration; a concentration of a substance being tested which will kill a test animal.

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LC_{50}	Lethal concentration 50; the concentration of a material in air which, on the basis of laboratory tests, is expected to kill 50% of a group of test animals when administered as a single exposure (usually 1 or 4 hours). The LC_{50} is expressed as parts of material per million parts of air, by volume (ppm) for gases and vapors, or as micrograms of material per liter of air (ug/L) or milligrams of material per cubic meter of air (mg/m^3) for dusts and mists, as well as for gases and vapors.
LD	Lethal dose; a concentration of a substance being tested which will kill a test animal.
LD_{50}	Lethal dose 50; a single dose of a material which on the basis of laboratory tests is expected to kill 50% of a group of test animals. The LD_{50} dose is usually expressed as milligrams or grams of material per kilogram of animal body weight (mg/kg or g/kg). If a material has a low LD_{50}, then only a very small amount is needed to cause an adverse effect and that substance would be considered highly toxic. Generally, substances with low LD_{50}s have high toxicity and vice versa.
LEL	Lower explosive limit or lower flammable limit of a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At concentrations lower than the LEL, the mixture is too "lean" to burn. Also see UEL.
LFL	Lower flammable limit. See LEL.
Liter	See L.
Local Exhaust	A system for capturing and exhausting contaminants from the air at the point where the contaminants are produced (welding, grinding, sanding, other processes or operations).

-------- M --------

M	Meter; a unit of length in the metric system. One meter is about 39 inches.
m^3	Cubic meter; a metric measure of volume, about 35.3 cubic feet or 1.3 cubic yards.
Malaise	A feeling of general discomfort, distress, or uneasiness, an out-of-sorts feeling.

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Mechanical Filter Respirator	A respirator used to protect against airborne particulate matter like dusts, mists, metal fume, and smoke. Mechanical filter respirators do not provide protection against gases, vapors, or oxygen deficient atmospheres.
Mechanical Ventilation	A powered device, such as a motor-driven fan or vacuum hose attachment, for exhausting contaminants from a workplace, vessel, or enclosure.
Melting point	The temperature at which a solid substance changes to a liquid state. For mixtures, the melting range may be given.
Meter	See **M.**
mg	Milligram; a metric unit of weight. There are 1,000 milligrams in one gram (g) of a substance. One gram is equivalent to almost 4/100th of an ounce.
mg/kg	Milligrams per kilogram; an expression of toxicological dose. See **g/kg.**
mg/m^3	Milligrams per cubic meter; a unit used to express concentrations of dusts, gases, fumes, or mists in air.
Micron	Micrometer; a unit of length equal to one millionth of a meter. A micron is approximately 1/25000 of an inch.
Mist	Suspended liquid droplets generated by condensation from the gaseous to the liquid state, or by breaking up a liquid into a dispersed state, such as splashing, foaming or atomizing. Mist is formed when a finely divided liquid is suspended in air.
Mixture	Any combination of two or more chemicals if the combination is not, in whole or part, the result of a chemical reaction.
mL	Milliliter; a metric unit of capacity, equal in volume to one cubic centimeter (cc), or about 1/16 of a cubic inch. There are 1,000 milliliters in one liter (L).
mmHg	Millimeters (mm) of mercury (Hg); a unit of measurement for low pressures or partial vacuums.
Molecular Weight	Weight (mass) of a molecule based on the sum of the atomic weights of the atoms that make up the molecule.

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mppcf	Million particles per cubic foot; a unit for measuring particles of a substance suspended in air. Exposure limits for mineral dusts (silica, graphite, Portland cement, nuisance dusts, and others), formerly expressed as mppcf, are now more commonly quoted in mg/m^3.
MSHA	The Mining Safety and Health Administration of the U.S. Department of the Interior; Federal agency with safety and health regulatory and enforcement authorities for the mining industry.
Mutagen	A material that alters a cell's genetic information and may lead to undesirable inherited conditions.

-------- N --------

Narcosis	A state of stupor, unconsciousness, or arrested activity produced by the influence of narcotics or other chemicals.
Natural Ventilation	Air movement caused by wind, temperature difference, or other non-mechanical factors.
Nausea	Tendency to vomit, feeling of sickness at the stomach.
NCI	National Cancer Institute. A component of the National Institutes of Health which studies cancer causes and prevention as well as diagnosis, treatment, and rehabilitation of cancer patients.
Nephrotoxin	A substance that causes injury to the kidneys.
Neurotoxin	A material that affects the nerve cells and may produce emotional or behavioral abnormalities.
Neutralize	To eliminate potential hazards by inactivating strong acids, caustics, and oxidizers. For example, acids can be neutralized by adding an appropriate amount of caustic substance to the spill.
NFPA	National Fire Protection Association; an international voluntary membership organization to promote/improve fire protection and prevention and establish safeguards against loss of life and property by fire. Best known on the industrial scene for the National Fire Codes - 16 volumes of codes, standards, recommended practices, and manuals developed (and periodically updated) by

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NFPA technical committees. Among these is NFPA 704M, the code for showing hazards of materials using the familiar diamond-shaped label or placard with appropriate numbers or symbols. The brief explanation on the next page illustrates the NFPA principle of using scales of 0 to 4 (low to high) to classify material hazard.

NIOSH — National Institute for Occupational Safety and Health of the Public Health Service, U.S. Department of Health and Human Services (DHHS); Federal agency which recommends occupational exposure limits for various substances and assists OSHA and MSHA in occupational safety and health investigations and research.

Nonflammable — Not easily ignited, or if ignited, not burning rapidly.

Non Sparking Tools — Tools made from beryllium - copper or aluminum - bronze greatly reduce the possibility of igniting dusts, gases, or flammable vapors. Although these tools may emit some sparks when striking metal, the sparks have a low heat content and are not likely to ignite most flammable liquids.

NRC — National Response Center; a notification center in the Coast Guard Building in Washington, DC, U.S., with a toll-free telephone number (1-800-424-8802) which must be called when significant oil or chemical spills or other environmentally related accidents occur.

NTP — National Toxicology Program. The NTP publishes an Annual Report on Carcinogens, a listing of potential carcinogens.

-------- O --------

Odor — A description of the smell of the substance.

Odor Threshold — The lowest concentration of a substance's vapor, in air, that can be smelled.

Olfactory — Relating to the sense of smell. The olfactory organ in the nasal cavity is the sensing element that detects odors and transmits information to the brain through the olfactory nerves.

Oral — Used in or taken into the body through the mouth.

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COMMON MSDS TERMS

NFPA Scale

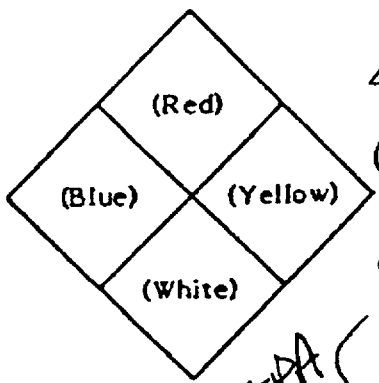
Fire Hazard (Red)

0 - Will not burn
1 - Will ignite if preheated
2 - Will ignite if moderately heated
3 - Will ignite at most ambient conditions
4 - Burns readily at ambient conditions

NFPA Scale

Health Hazard (Blue)

0 - Ordinary combustible hazards in a fire
1 - Slightly hazardous
2 - Hazardous
3 - Extreme danger
4 - Deadly



Reactivity (Yellow)

0 - Stable and not reactive with water
1 - Unstable if heated
2 - Violent chemical change
3 - Shock and heat may detonate
4 - May detonate

NFPA Scale

Specific Hazard (White)

OX	Oxidizer
ACID	Acid
ALK	Alkali
COR	Corrosive
-W-	Use No Water
☢	Radiation Hazard

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Oral Toxicity	Adverse effects resulting from taking a substance into the body via the mouth. Ordinarily used to denote effects in experimental animals.
Organic Peroxide	An organic compound that contains the bivalent -O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical. Some organic peroxides are highly unstable, and may decompose with explosive force.
OSHA	Occupational Safety and Health Administration of the U.S. Department of Labor; Federal agency with safety and health regulatory and enforcement authorities for most U.S. industry and business.
Overexposure	Exposure to a hazardous material beyond the allowable exposure levels.
Oxidizer	A chemical other than a blasting agent or explosive as defined in 29CFR 1910.109(a) that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. Chlorate (CLO_3), permanganate (MnO_4), and nitrate (NO_3) compounds are examples of oxiders; note that all contain oxygen (O).

-------- P --------

PEL	Permissible exposure limit; the legally enforced exposure limit for a substance established by OSHA regulatory authority. The PEL indicates the permissible concentration of air contaminants to which nearly all workers may be repeatedly exposed eight (8) hours a day, forty (40) hours a week, over a working lifetime (30 years) without adverse health effects.
% Volatile	Percent volatile by volume; the percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature of 70°F (unless some other temperature is stated). Examples: butane, gasoline, and paint thinner (mineral spirits) are 100% volatile; their individual evaporation rates vary, but over a period of time each will evaporate completely.
pH	The symbol relating the hydrogen ion (H^-) concentration to that of a given standard solution. A pH of 7 is neutral. Numbers increasing from 7 to 14 indicate greater alkalinity. Numbers decreasing from 7 to 0 indicate greater acidity.

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Physical Hazard	A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.
PMCC	Pensky-Martens Closed Cup; a flash point test method.
Pneumoconiosis	A condition of the lung in which there is permanent deposition of particulate matter and the tissue reaction to its presence. It may range from relatively harmless forms of iron oxide deposition to destructive forms of silicosis.
Poison, Class A	A DOT hazard class for extremely dangerous poisons, that is, poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. Some examples: phosgene, cyanogen, hydrocyanic acid, nitrogen peroxide.
Poison, Class B	A DOT hazard class for liquid, solid, paste, or semi-solid substances - other than Class A poisons or irritating materials - which are known (or presumed on the basis of animal tests) to be so toxic to man as to afford a hazard to health during transportation. Some examples: arsenic, beryllium chloride, cyanide, mercuric oxide.
Polymerization	See **Hazardous Polymerization.**
ppb	Parts per billion; a unit for measuring the concentration of a gas or vapor in air - parts (by volume) of the gas or vapor in a billion parts of air. Usually used to express measurements of extremely low concentrations of unusually toxic gases or vapors. Also used to indicate the concentration of a particular substance in a liquid or solid. For example, one part per billion is analogous to one second every 32 years, or one penny out of $10,000,000.
ppm	Parts per million; a unit for measuring the concentration of a gas or vapor in air - parts (by volume) of the gas or vapor in a million parts of air. Also used to indicate the concentration of a particular substance in a liquid or solid. For example, one part per million is analogous to one inch in sixteen miles, one minute every two years, or one penny out of $10,000.

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psi	Pounds per square inch; for MSDS purposes, a unit for measuring the pressure a material exerts on the walls of a confining vessel or enclosure. For technical accuracy, pressure must be expressed as psig (pounds per square inch gauge) or psia (pounds per square inch absolute; that is, gauge pressure plus sea level atmospheric pressure, of psig plus about 14.7 pounds per square inch). Also see **mmHg**.
Pulmonary	Relating to, or associated with, the lungs.
Pulmonary Edema	Fluid in the lungs.
Pyrophoric	A chemical that will ignite spontaneously in air at a temperature of 130°F (54.4C) or below.
	-------- R --------
Reaction	A chemical transformation or change; the interaction of two or more substances to form new substances.
Reactive	See **Unstable**.
Reactivity	A description of the tendency of a substance to undergo chemical reaction with the release of energy. Undesirable effects - such as pressure buildup, temperature increase, formation of noxious, toxic, or corrosive by-products - may occur because of the reactivity of a substance to heating, burning, direct contact with other materials or other conditions in use or in storage.
Reducing Agent	In a reduction reaction (which always occurs simultaneously with an oxidation reaction) the reducing agent is the chemical or substance which (1) combines with oxygen or (2) loses electrons to the reaction.
Reproductive Toxin	Substances that affect either male or female reproductive systems and may impair the ability to have children.
Respiratory Protection	Devices that will protect the wearer's respiratory system from overexposure by inhalation to airborne contaminants. Respiratory protection is used when a worker must work in an area where he/she might be exposed to concentrations in excess of the allowable exposure limit.

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Respiratory System	The breathing system; includes the lungs and air passages (trachea or "windpipe", larynx, mouth, and nose) to the air outside the body, plus the associated nervous and circulatory supply.
RCRA	Resource Conservation and Recovery Act; Federal environmental legislation, administered by EPA, aimed at controlling the generation, treating, storage, transportation, and disposal of hazardous wastes.
Routes of Entry	The means by which material may gain access to the body, for example, inhalation, ingestion, and skin contact.

-------- S --------

SCBA	See **Self-Contained Breathing Apparatus.**
Self-Contained Breathing Apparatus	A respiratory protection device that consists of a supply or a means of respirable air, oxygen, or oxygen generating material, carried by the wearer.
Self-Ignition	See **Auto-Ignition Temperature.**
Sensitizer	A substance which, on first exposure, causes little or no reaction in man or test animals but which, on repeated exposure, may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization to a few chemicals is also known to occur. Examples of sensitizers include poison ivy, pollen, and some isocyanates and epoxy resin hardeners.
SETA	Setaflash Closed Tester; a flash point test method.
Silicosis	A disease of the lungs caused by the inhalation of silica dust.
"Skin"	A notation, sometimes used with PEL or TLV exposure data; indicates that the stated substance may be absorbed by the skin, mucous membranes, and eyes -either airborne or by direct contact - and that this additional exposure should be considered part of the total exposure.

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Skin Absorption — Ability of some hazardous chemicals to pass directly through the skin and enter the bloodstream.

Skin Sensitizer — See **Sensitizer.**

Skin Toxicity — See **Dermal Toxicity.**

Solubility in Water — A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature. Solubility information can be useful in determining spill cleanup methods and fire-extinguishing agents and methods for a material. Terms used to express solubility are:

negligible	Less than 0.1 percent
slight	0.1 to 1.0 percent
moderate	1 to 10 percent
appreciable	more than 10 percent
complete	soluble in all proportions

Solvent — A substance, usually a liquid, in which other substances are dissolved. The most common solvent is water.

Sorbents — Non-reactive materials used to clean up chemical spills. Examples: clay and vermiculite.

Special Fire Fighting Procedures — Special procedures and/or personal protective equipment that is necessary when a particular substance is involved in a fire.

Species — A biological type; on MSDSs, species refers to the test animals - usually rats, mice, or rabbits -which were used to obtain the toxicity test data reported.

Specific Gravity — The weight of a material compared to the weight of an equal volume of water; an expression of the density (or heaviness) of the material. Example: if a volume of a material weighs 8 pounds, and an equal volume of water weighs 10 pounds, the material is said to have a specific gravity of 0.8.

$$\frac{8 \text{ lbs}}{10 \text{ lbs}} = 0.8$$

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Insoluble materials with specific gravity of less than 1.0 will float in (or on) water. Insoluble materials with specific gravity greater than 1.0 will sink (or go to the bottom) in water. Most (but not all) flammable liquids have specific gravity less than 1.0 and, if not soluble, will float on water - an important consideration for fire suppression and spill clean-up.

Spill or Leak Procedures — The methods, equipment, and precautions that should be used to control or clean up a leak or spill.

Splash Proof Goggles — Eye protection made of a non-corrosive material that fits snugly against the face, and has indirect ventilation ports.

Spontaneously Combustible — A material that ignites as a result of retained heat from processing, or which will oxidize to generate heat and ignite, or which absorbs moisture to generate heat and ignite.

Stability — An expression of the ability of a material to remain unchanged. For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions which may cause instability (dangerous change) are stated - examples, temperatures above 150°F, shock from dropping.

STEL — Short term exposure limit; ACGIH terminology. See **TLV.**

Superfund — See **CERCLA.**

Supplied Air Respirators — Air line respirators or self-contained breathing apparatus.

Synonym — Another name or names by which a material is known. Methyl alcohol, for example, is also known as methanol, or wood alcohol.

Systemic Poison — A poison which spreads throughout the body, affecting all body systems and organs. Its adverse effect is not localized in one spot or area.

Systemic Toxicity — Adverse effects caused by a substance which affects the body in a general rather than local manner.

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-------- T --------

Target Organ Toxin — A toxic substance that attacks a specific organ of the body. For example, overexposure to carbon tetrachloride can cause liver damage.

TCC — Tag (Tagliabue) Closed Cup; a flash point test method.

Teratogen — A substance or agent to which exposure of a pregnant female can result in malformations in the fetus. An example is thalidomide.

TLV — Threshold Limit Value; a term used by ACGIH to express the airborne concentration of a material to which nearly all persons can be exposed day after day, without adverse effects. ACGIH expresses TLVs in three ways:

TLV-TWA: the allowable Time Weighted Average concentration for a normal 8-hour work day or 40-hour work week.

TLV-STEL: the Short-Term Exposure Limit, or maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA is not exceeded).

TLV-C: the Ceiling limit - the concentration that should not be exceeded even instantaneously.

Also see "Skin".

TOC — TAG Open Cup; a flash point test method.

Toxic Substance — Any substance which can cause acute or chronic injury to the human body, or which is suspected of being able to cause diseases or injury under some conditions.

Toxicity — The sum of adverse effects resulting from exposure to a material, generally by the mouth, skin, or respiratory tract.

Trade Name — The trademark name or commercial trade name for a material.

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Trade Secret	Any confidential formula pattern, process, device, information or compilation of information (including chemical name or other unique chemical identifier) that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.
TSCA	Toxic Substances Control Act; Federal environmental legislation, administered by EPA, for regulating the manufacture, handling, and use of materials classified as "toxic substances".
TWA	Time weighted average exposure; ACGIH terminology. See **TLV.**

-------- U --------

UEL	Upper explosive limit or upper flammable limit of a vapor or gas; the highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At higher concentrations, the mixture is too "rich" to burn. Also see **LEL.**
UFL	See **UEL.**
UN Number	A registry number assigned to dangerous commonly carried goods by the United Nations Committee of Experts on the Transport of Dangerous Goods. This UN number is required in shipping documentation and on packaging as part of the DOT regulations for shipping hazardous materials.
Unstable	A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature. These chemicals are also referred to as reactive.
Unusual Fire and Explosion Hazards	Hazards that might occur as a result of overheating or burning a specific material. These include chemical reactions or changes in chemical composition or any special hazards involved in extinguishing the burning material.

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USDA

U.S. Department of Agriculture; prior to 1971, USDA performed tests and issued approvals on respirators for use with pesticides. In 1971, the Bureau of Mines took over the pesticide respirator testing/approval functions - procedures later delegated to the Testing and Certification Branch (TCB) of NIOSH.

-------- V --------

Vapor

The gaseous form a solid or liquid substance as it evaporates.

Vapor Density

The weight of a vapor or gas compared to the weight of an equal volume of air; an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0 (examples: acetylene, methane, hydrogen). Materials heavier than air (examples: propane, hydrogen sulfide, ethane, butane, chlorine, sulfur dioxide) have vapor densities greater than 1.0. All vapors and gases will mix with air, but the lighter materials will tend to rise and dissipate (unless confined). Heavier vapors and gases are likely to concentrate in low places - along or under floors, in sumps, sewers and manholes, in trenches and ditches - where they may create fire or health hazards.

Vapor Pressure

The pressure exerted by a saturated vapor above its own liquid in a closed container. When quality control tests are performed on products the test temperature is usually 100°F and the vapor pressure is expressed as pounds per square inch (psig or psia) - but vapor pressures reported on MSDSs are in millimeters of mercury (mmHg) at 68°F (20°C), unless stated otherwise. Three facts are important to remember:

1. Vapor pressure of a substance at 100°F will always be higher than the vapor pressure of the substance at 68°F (20°C).

2. Vapor pressures reported on MSDSs in mmHg are usually very low pressures; 760 mmHg is equivalent to 14.7 pounds per square inch.

3. The lower the boiling point of a substance, the higher its vapor pressure.

Ventilation

Circulating fresh air to replace contaminated air.

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Vermiculite	An expanded mica (hydrated magnesium-aluminum-iron silicate) used as sorbent for spill control and clean-up.
Volatility	A measure of how quickly a substance forms a vapor at ordinary temperatures.
Viscosity	The tendency of a fluid to resist internal flow without regard to its density.

-------- W --------

Waste Disposal Methods	Proper disposal methods for contaminated material, recovered liquids or solids, and their containers.
Water-Reactive	A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

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OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART C—GENERAL SAFETY AND HEALTH PROVISIONS

(Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, 43 FR 31019, July 19, 1978; republished at 43 FR 31329, July 21, 1978; amended by 45 FR 35212, May, 23, 1980; corrected by 45 FR 54333, August 15, 1980)

Subpart C—General Safety and Health Provisions

§ 1910.20 Access to employee exposure and medical records.

[Editor's note: The Occupational Safety and Health Administration February 11, 1983 (48 FR 6332) extended a partial stay for the flavor and fragrance industries of 29 CFR 1910.20 on access to employee exposure and medical records. The partial stay was extended from February 15, 1983, to August 1, 1983, to allow OSHA to consider issues presented by the affected industries during current rulemaking on revising the rule. OSHA August 12, 1983 (48 FR 36576) further extended the stay from August 1, 1983 to February 1, 1984 to continue considering the above mentioned issues.

[1910.20(a) corrected by 45 FR 54333, August 15, 1980]

(a) *Purpose.* The purpose of this section is to provide employees and their designated representatives a right of access to relevant exposure and medical records, and to provide representatives of the Assistant Secretary a right of access to these records in order to fulfill responsibilities under the Occupational Safety and Health Act. Access by employees, their representatives, and the Assistant Secretary is necessary to yield both direct and indirect improvements in the detection, treatment, and prevention of occupational disease. Each employer is responsible for assuring compliance with this section, but the activities involved in complying with the access to medical records provisions can be carried out, on behalf of the employer, by the physician or other health care personnel in charge of employee medical records. Except as expressly provided, nothing in this section is intended to affect existing legal and ethical obligations concerning the maintenance and confidentiality of employee medical information, the duty to disclose information to a patient/employee or any other aspect of the medical-care relationship, or affect existing legal obligations concerning the protection of trade secret information.

(b) *Scope and application.* (1) This section applies to each general industry, maritime, and construction employer who makes, maintains, contracts for, or has access to employee exposure or medical records, or analyses thereof, pertaining to employees exposed to toxic substances or harmful physical agents.

(2) This section applies to all employee exposure and medical records, and analyses thereof, of employees exposed to toxic substances or harmful physical agents, whether or not the records are related to specific occupational safety and health standards.

(3) This section applies to all employee exposure and medical records, and analyses thereof, made or maintained in any manner, including on an in-house or contractual (e.g., fee-for-service) basis. Each employer shall assure that the preservation and access requirements of this section are complied with regardless of the manner in which records are made or maintained.

(c) *Definitions.* (1) "Access" means the right and opportunity to examine and copy.

(2) "Analysis using exposure or medical records" means any compilation of data, or any research, statistical or other study based at least in part on information collected from individual employee exposure or medical records or information collected from health insurance claims records, provided that either the analysis has been reported to the employer or no further work is currently being done by the person responsible for preparing the analysis.

(3) "Designated representative" means any individual or organization to whom an employee gives written authorization to exercise a right of access. For the purposes of access to employee exposure records and analyses using exposure or medical records, a recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

(4) "Employee" means a current employee, a former employee, or an employee being assigned or transferred to work where there will be exposure to toxic substances or harmful physical agents. In the case of a deceased or legally incapacitated employee, the employee's legal representative may directly exercise all the employee's rights under this section.

(5) "Employee exposure record" means a record containing any of the following kinds of information

[Sec. 1910.20(c)(5)]

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concerning employee exposure to toxic substances or harmful physical agents:

(i) environmental (workplace) monitoring or measuring, including personal, area, grab, wipe, or other form of sampling, as well as related collection and analytical methodologies, calculations, and other background data relevant to interpretation of the results obtained;

(ii) biological monitoring results which directly assess the absorption of a substance or agent by body systems (e.g., the level of a chemical in the blood, urine, breath, hair, fingernails, etc.) but not including results which assess the biological effect of a substance or agent;

(iii) material safety data sheets; or

(iv) in the absence of the above, any other record which reveals the identity (e.g., chemical, common, or trade name) of a toxic substance or harmful physical agent.

(8)(i) "Employee medical record" means a record concerning the health status of an employee which is made or maintained by a physician, nurse, or other health care personnel, or technician, including:

(A) medical and employment questionnaires or histories (including job description and occupational exposures),

(B) the results of medical examinations (pre-employment, pre-assignment, periodic, or episodic) and laboratory tests (including X-ray examinations and all biological monitoring),

(C) medical opinions, diagnoses, progress notes, and recommendations,

(D) descriptions of treatments and prescriptions, and

(E) employee medical complaints.

(ii) "Employee medical record" does not include the following:

(A) physical specimens (e.g., blood or urine samples) which are routinely discarded as a part of normal medical practice, and are not required to be maintained by other legal requirements,

(B) records concerning health insurance claims if maintained separately from the employer's medical program and its records, and not accessible to the employer by employee name or other direct personal identifier (e.g., social security number, payroll number, etc.), or

(C) records concerning voluntary employee assistance programs (alcohol, drug abuse, or personal counseling programs) if maintained separately from the employer's medical program and its records.

(7) "Employer" means a current employer, a former employer, or a successor employer.

(9) "Exposure" or "exposed" means that an employee is subjected to a toxic substance or harmful physical agent in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption, etc.), and includes past exposure and potential (e.g., accidental or possible) exposure, but does not include situations where the employer can demonstrate that the toxic substance or harmful physical agent is not used, handled, stored, generated, or present in the workplace in any manner different from typical non-occupational situations.

(9) "Record" means any item, collection, or grouping of information regardless of the form or process by which it is maintained (e.g., paper document, microfiche, microfilm, X-ray film, or automated data processing).

(10) "Specific written consent" (i) means a written authorization containing the following:

(A) the name and signature of the employee authorizing the release of medical information,

(B) the date of the written authorization

(C) the name of the individual or organization that is authorized to release the medical information,

(D) the name of the designated representative (individual or organization) that is authorized to receive the released information,

(E) a general description of the medical information that is authorized to be released,

(F) a general description of the purpose for the release of the medical information, and

(G) a date or condition upon which the written authorization will expire (if less than one year).

(ii) A written authorization does not operate to authorize the release of medical information not in existence on the date of written authorization, unless this is expressly authorized, and does not operate for more than one year from the date of written authorization.

(iii) A written authorization may be revoked in writing prospectively at any time.

(11) "Toxic substance or harmful physical agent" means any chemical substance, biological agent (bacteria, virus, fungus, etc.), or physical stress (noise, heat, cold, vibration, repetitive motion, ionizing and non-ionizing radiation, hypo- or hyperbaric pressure, etc.) which:

(i) is regulated by any Federal law or rule due to a hazard to health,

(ii) is listed in the latest printed edition of the National Institute for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) (See Appendix B),

(iii) has yielded positive evidence of an acute or chronic health hazard in human, animal, or other biological testing conducted by, or known to, the employer, or

(iv) has a material safety data sheet available to the employer indicating that the material may pose a hazard to human health.

(d) *Preservation of records.* (1) Unless a specific occupational safety and health standard provides a different period of time, each employer shall assure the preservation and retention of records as follows:

(i) *Employee medical records.* Each employee medical record shall be preserved and maintained for at least the duration of employment plus thirty (30) years, except that health insurance claims records maintained separately from the employer's medical program and its records need not be retained for any specified period;

(ii) *Employee exposure records.* Each employee exposure record shall be preserved and maintained for at least thirty (30) years, except that:

(A) Background data to environmental (workplace) monitoring or measuring, such as laboratory reports and worksheets, need only be retained for one (1) year so long as the sampling results, the collection methodology (sampling plan), a description of the analytical and mathematical methods used, and a summary of other background data relevant to interpretation of the results obtained, are retained for at least thirty (30) years; and

[1910.20(d)(1)(ii)(A) corrected by 45 FR 54333, August 15, 1980]

(B) Material safety data sheets and paragraph (c)(5)(iv) records concerning the identity of a substance or agent need not be retained for any specified period as long as some record of the identity (chemical name if known) of the substance or agent, where it was used, and when it was used is retained for at least thirty (30) years; and

(iii) *Analyses using exposure or medical records.* Each analysis using exposure or medical records shall be preserved and maintained for at least thirty (30) years.

(2) Nothing in this section is intended to mandate the form, manner, or process by which an employer preserves a record so long as the information contained in the record is preserved and retrievable, except that X-ray films shall be preserved in their original state.

(e) *Access to records.* (1) *General.* (i) Whenever an employee or designated representative requests access to a record, the employer shall assure that access is provided in a reasonable time.

[Sec. 1910.20(e)(1)(i)]

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place, and manner, but in no event later than fifteen (15) days after the request for access is made.

(ii) Whenever an employee or designated representative requests a copy of a record, the employer shall, within the period of time previously specified, assure that either:

(A) a copy of the record is provided without cost to the employee or representative,

(B) the necessary mechanical copying facilities (e.g., photocopying) are made available without cost to the employee or representative for copying the record, or

(C) the record is loaned to the employee or representative for a reasonable time to enable a copy to be made.

(iii) Whenever a record has been previously provided without cost to an employee or designated representative, the employer may charge reasonable, non-discriminatory administrative costs (i.e., search and copying expenses but not including overhead expenses) for a request by the employee or designated representative for additional copies of the record, except that

(A) An employer shall not charge for an initial request for a copy of new information that has been added to a record which was previously provided; and

(B) An employer shall not charge for an initial request by a recognized or certified collective bargaining agent for a copy of an employee exposure record or an analysis using exposure or medical records.

(iv) Nothing in this section is intended to preclude employees and collective bargaining agents from collectively bargaining to obtain access to information in addition to that available under this section.

(2) *Employee and designated representative access.* (i) *Employee exposure records.* Each employer shall, upon request, assure the access of each employee and designated representative to employee exposure records relevant to the employee. For the purpose of this section, exposure records relevant to the employee consist of:

(A) records of the employee's past or present exposure to toxic substances or harmful physical agents,

(B) exposure records of other employees with past or present job duties or working conditions related to or similar to those of the employee,

(C) records containing exposure information concerning the employee's workplace or working conditions, and

(D) exposure records pertaining to workplaces or working conditions to which the employee is being assigned or transferred.

(ii) *Employee medical records.* (A) Each employer shall, upon request, assure the access of each employee to employee medical records of which the employee is the subject, except as provided in paragraph (e)(2)(ii)(D) below.

(B) Each employer shall, upon request, assure the access of each designated representative to the employee medical records of any employee who has given the designated representative specific written consent. Appendix A to this section contains a sample form which may be used to establish specific written consent for access to employee medical records.

(C) Whenever access to employee medical records is requested, a physician representing the employer may recommend that the employee or designated representative:

(*1*) consult with the physician for the purposes of reviewing and discussing the records requested,

(*2*) accept a summary of material facts and opinions in lieu of the records requested, or

(*3*) accept release of the requested records only to a physician or other designated representative.

(D) Whenever an employee requests access to his or her employee medical records, and a physician representing the employer believes that direct employee access to information contained in the records regarding a specific diagnosis of a terminal illness or a psychiatric condition could be detrimental to the employee's health, the employer may inform the employee that access will only be provided to a designated representative of the employee having specific written consent, and deny the employee's request for direct access to this information only. Where a designated representative with specific written consent requests access to information so withheld, the employer shall assure the access of the designated representative to this information, even when it is known that the designated representative will give the information to the employee.

(E) Nothing in this section precludes a physician, nurse, or other responsible health care personnel maintaining employee medical records from deleting from requested medical records the identity of a family member, personal friend, or fellow employee who has provided confidential information concerning an employee's health status.

(iii) *Analyses using exposure or medical records.*

(A) Each employer shall, upon request, assure the access of each employee and designated representative to each analysis using exposure or medical records concerning the employee's working conditions or workplace.

(B) Whenever access is requested to an analysis which reports the contents of employee medical records by either direct identifier (name, address, social security number, payroll number, etc.) or by information which could reasonably be used under the circumstances indirectly to identify specific employees (exact age, height, weight, race, sex, date of initial employment, job title, etc.), the employer shall assure that personal identifiers are removed before access is provided. If the employer can demonstrate that removal of personal identifiers from an analysis is not feasible, access to the personally identifiable portions of the analysis need not be provided.

(3) *OSHA access.* (i) Each employer shall, upon request, assure the immediate access of representatives of the Assistant Secretary of Labor for Occupational Safety and Health to employee exposure and medical records and to analyses using exposure or medical records. Rules of agency practice and procedure governing OSHA access to employee medical records are contained in 29 CFR 1913.10.

(ii) Whenever OSHA seeks access to personally identifiable employee medical information by presenting to the employer a written access order pursuant to 29 CFR 1913.10(d), the employer shall prominently post a copy of the written access order and its accompanying cover letter for at least fifteen (15) working days.

(f) *Trade secrets.* (1) Except as provided in paragraph (f)(2) of this section, nothing in this section precludes an employer from deleting from records requested by an employee or designated representative any trade secret data which discloses manufacturing processes, or discloses the percentage of a chemical substance in a mixture, as long as the employee or designated representative is notified that information has been deleted. Whenever deletion of trade secret information substantially impairs evaluation of the place where or the time when exposure to a toxic substance or harmful physical agent occurred, the employer shall provide alternative information which is sufficient to permit the employee to identify where and when exposure occurred.

(2) Notwithstanding any trade secret claims, whenever access to records is requested, the employer shall provide

[Sec. 1910.20(f)(2)]

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access to chemical or physical agent identities including chemical names, levels of exposure, and employee health status data contained in the requested records.

(3) Whenever trade secret information is provided to an employee or designated representative, the employer may require, as a condition of access, that the employee or designated representative agree in writing not to use the trade secret information for the purpose of commercial gain and not to permit misuse of the trade secret information by a competitor or potential competitor of the employer.

(g) *Employee information.* (1) Upon an employee's first entering into employment, and at least annually thereafter, each employer shall inform employees exposed to toxic substances or harmful physical agents of the following:

(i) the existence, location, and availability of any records covered by this section;

(ii) the person responsible for maintaining and providing access to records; and

(iii) each employee's rights of access to these records.

(2) Each employer shall make readily available to employees a copy of this standard and its appendices, and shall distribute to employees any informational materials concerning this standard which are made available to the employer by the Assistant Secretary of Labor for Occupational Safety and Health.

(h) *Transfer of records.* (1) Whenever an employer is ceasing to do business, the employer shall transfer all records subject to this section to the successor employer. The successor employer shall receive and maintain these records.

(2) Whenever an employer is ceasing to do business and there is no successor employer to receive and maintain the records subject to this standard, the employer shall notify affected employees of their rights of access to records at least three (3) months prior to the cessation of the employer's business.

(3) Whenever an employer either is ceasing to do business and there is no successor employer to receive and maintain the records, or intends to dispose of any records required to be preserved for at least thirty (30) years, the employer shall:

(i) transfer the records to the Director of the National Institute for Occupational Safety and Health (NIOSH) if so required by a specific occupational safety and health standard; or

(ii) notify the Director of NIOSH in writing of the impending disposal of records at least three (3) months prior to the disposal of the records.

(4) Where an employer regularly disposes of records required to be preserved for at least thirty (30) years, the employer may, with at least (3) months notice, notify the Director of NIOSH on an annual basis of the records intended to be disposed of in the coming year.

(i) *Appendices.* The information contained in the appendices to this section is not intended, by itself, to create any additional obligations not otherwise imposed by this section nor detract from any existing obligation.

(j) *Effective date.* This section shall become effective on August 21, 1980. All obligations of this section commence on the effective date except that the employer shall provide the information required under paragraph (g)(1) of this section to all current employees within sixty (60) days after the effective date.

Appendix A to § 1910.20—Sample Authorization Letter for the Release of Employee Medical Record Information to a Designated Representative

I, ————, (full name of worker/patient) hereby authorize ———— (individual or organization holding the medical records) to release to ———— (individual or organization authorized to receive the medical information), the following medical information from my personal medical records:

_____

_____

(Describe generally the information desired to be released).

I give my permission for this medical information to be used for the following purpose: ————, but I do not give permission for any other use or re-disclosure of this information.

(Note.—Several extra lines are provided below so that you can place additional restrictions on this authorization letter if you want to. You may, however, leave these lines blank. On the other hand, you may want to (1) specify a particular expiration date for this letter (if less than one year); (2) describe medical information to be created in the future that you intend to be covered by this authorization letter; or (3) describe portions of the medical information in your records which you do not intend to be released as a result of this letter.)

_____

_____

_____

_____

_____

Full name of Employee or Legal Representative

_____

Signature of Employee or Legal Representative

_____

Date of Signature

Appendix B to § 1910.20—Availability of NIOSH Registry of Toxic Effects of Chemical Substances (RTECS) [1]

[Appendix B corrected by 45 FR 54333, August 15, 1980]

The final standard, 29 CFR 1910.20, applies to all employee exposure and medical records, and analyses thereof, of employees exposed to toxic substances or harmful physical agents (paragraph (b)(2)). The term "toxic substance or harmful physical agent" is defined by paragraph (c)(11) to encompass chemical substances, biological agents, and physical stresses for which there is evidence of harmful health effects. The standard uses the latest printed edition of the National Institute for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) as one of the chief sources of information as to whether evidence of harmful health effects exists. If a substance is listed in the latest printed RTECS, the standard applies to exposure and medical records (and analyses of these records) relevant to employees exposed to the substance.

It is appropriate to note that the final standard does not require that employers purchase a copy of RTECS; and many employers need not consult RTECS to ascertain whether their employee exposure or medical records are subject to the standard. Employers who do not currently have the latest printed edition of the NIOSH RTECS, however, may desire to obtain a copy. The RTECS is issued in an annual printed edition as mandated by section 20(a)(6) of the Occupational Safety and Health Act (29 U.S.C. 669(a)(6)). The 1978 edition is the most recent printed edition as of May 1, 1980. Its Foreward and Introduction describes the RTECS as follows:

"The annual publication of a list of known toxic substances is a NIOSH mandate under the Occupational Safety and Health Act of 1970. It is intended to provide basic information on the known toxic and biological effects of chemical substances for the use of employers, employees, physicians, industrial hygienists, toxicologists, researchers, and, in general, anyone concerned with the proper and safe handling of chemicals. In turn, this information may contribute to a better understanding of potential occupational hazards by everyone involved and ultimately may help to bring about a more healthful workplace environment. (p. iii)

"This Registry contains 124,247 listings of chemical substances: 33,929 are names of different chemicals with their associated toxicity data and 90,318 are synonyms. This edition includes approximately 7,500 new chemical compounds that did not appear in the 1977 Registry. (p. xiii)

"The Registry's purposes are many, and it serves a variety of users. It is a single source document for basic toxicity information and for other data, such as chemical identifiers and information necessary for the preparation of safety directives and hazard

[1] On April 24, 1980 the Director of the Federal Register approved for incorporation by reference into 29 CFR 1910, the 1978 edition of the National Institute for Occupational Safety and Health Registry of Toxic Effects of Chemical Substances (the Registry). (See 29 CFR 1910.20 (c)(11)(ii))

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evaluations for chemical substances. The various types of toxic effects linked to literature citations provide researchers and occupational health scientists with an introduction to the toxicological literature, making their own review of the toxic hazards of a given substance easier. By presenting data on the lowest reported doses that produce effects by several routes of entry in various species, the Registry furnishes valuable information to those responsible for preparing safety data sheets for chemical substances in the workplace. Chemical and production engineers can use the Registry to identify the hazards which may be associated with chemical intermediates in the development of final products, and thus can more readily select substitutes or alternate processes which may be less hazardous. (p. xiii)

"In this edition of the Registry, the editors intend to identify "all known toxic substances" which may exist in the environment and to provide pertinent data on the toxic effects from known doses entering an organism by any route described. Data may be used for the evaluation of chemical hazards in the environment, whether they be in the workplace, recreation area, or living quarters. (p. xiii)

"It must be reemphasized that the entry of a substance in the Registry does not automatically mean that it must be avoided. A listing does mean, however, that the substance has the documented potential of being harmful if misused, and care must be exercised to prevent tragic consequences. (p. xiv)"

The RTECS 1978 printed edition may be purchased for $13.00 from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, D.C. 20402 (202-783-3238) (Order GPO Stock No. 017-033-00348-7). The 1979 printed edition is anticipated to be issued in the summer of 1980. Some employers may also desire to subscribe to the quarterly update to the RTECS which is published in a microfiche edition. An annual subscription to the quarterly microfiche may be purchased from the GPO for $14.00 (Order the "Microfiche Edition, Registry of Toxic Effects of Chemical Substances"). Both the printed edition and the microfiche edition of RTECS are available for review at many university and public libraries throughout the country. The latest RTECS editions may also be examined at the OSHA Technical Data Center, Room N2439-Rear, United States Department of Labor, 200 Constitution Avenue, N.W., Washington, D.C. 20210 (202-523-8700), or at any OSHA Regional or Area Office (*See*, major city telephone directories under United States Government-Labor Department).

[Section 1910.20 issued as interim rule, effective July 19, 1978, at 43 FR 31309, July 19, 1978; republished at 43 FR 31329, July 21, 1978; amended at 45 FR 33212, May 23, 1980, effective August 21, 1980]

(Sec. 1910.20, Appendix B)

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MATERIAL SAFETY DATA SHEETS

MAINTENANCE DEPARTMENT

FIELD AREAS AND SHOPS

ABRASIVE GRINDING PRODUCTS

ACETONE

ACETYLENE

ACRYLONITRILE

ALUMINUM (PLATE)

ANTIFREEZE - ETHYLENE GLYCOL

ARGON

BRASS

CALCIUM CARBONATE

CALCILUM CHLORIDE

CARBOLINE THINNER #25

CARBOLINE THINNER #26

CARBON DIOXIDE

CARBON MONOXIDE

CEILCOTE FIBERGLASS

- HARDENER NO. 2
- HARDENER NO. 3
- LINING 25
- LINING 74
- P-370 PRIMER
- CLOTHS
- TYPE S POWDER

CELLOSOLVE SOLVENT

UCC 002440

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MSDS - FIELD & SHOPS (CONT.)

CEMENT (BLACK)

CEMENT (WHITE)

CIMFREE 104, 106, 108, 200, 234, 238

COPPER

COPPER ALLOY

DIESEL FUEL #2

ENGINE CLEANER

FILTROL GRADE 13

FREEALL PENETRANT

FURAN FILLER - SEALCOAT "BINDER"

FURAN FILLER - SEALCOAT "POWDER"

GALVANIZING COMPOUND (AEROSOL)

GALVANIZING COMPOUND (COLD)

GASOLINE REGULAR

GASOLINE UNLEADED

GLYCERINE

GOGGLE CLEANER

HELIUM

HI SOL 15

HYDROGEN PEROXIDE - 30%

INSULATION MATERIALS

AEROTUBE PIPE/SHEET

AEROTUBE II PIPE/SHEET

ALKOTE (HEAVY GRADE)

ANTI-ABRASIVE 2A COATING

ASBESTOS

BERYLLIUM OXIDE

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MSDS - FIELD & SHOPS (CONT.)

BURLGLAS 1200

CADALON 500 GREY

CADALON 540

CERAMIC FIBER

CORK-FILLED VINYL MASTIC

FIBER GLASS INSULATION

FIBERGLAS

FIBERGLASS/ASJ-SSL

FIBREX BONDED PRODUCTS

FIBROUS GLASS

FOAMGLAS

FOSTER FIBROUS ADHESIVE

GOODTEMP 1500

HILBOARD 1212

HILCOVER 8,10,12

JAXSAN 600 & 601

KAPTON

KAYLO 10 AF

MICRO-LOK

PABCO

PABCOTE CEMENT

PITTCOTE 300

PITTSEAL III SEALANT

PROTEXULATE

PVC

RUBATEX FLEXIBLE FOAM

SPIN GLAS 812 - 817

UCC 002442

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SPIN GLAS 1001

TEMP-MAT

THERMO-12

THERMOKOTE

VITREOUS SILICA

ISOPROPANOL

LUBRICANTS AND OILS:

GREASE

GREASE - TEXACO MARFAX #2

GULFCUT 11D

GULFCUT 45A

GULF MULTI-PURPOSE GEAR LUB. 80W/90

GLUF SUPER DUTY MOTOR OIL 30

KEROSENE

MOBILE DTE 797

NUTO H 68

OIL - EXXON 1243

OIL SAE 15W-40 (AMOCO 300)

PENNZOIL GEARSHIELD FLUID 3000

ROTELLA T OIL (SHELL)

STEAM CYLINDER OIL #6

STEAM CYLINDER OIL #8

TERESSTIC 46

UCON 150 EP, 220 EP

ZERICE 68

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MSDS - FIELD & SHOPS (CONT.)

MAGNESOL (FILTER AID)

MERCURY (METAL)

METHANE

METHANOL

METHYL ETHYL KETONE

MURATIC ACID

NAPHTHA

NAPHTHALENE

NATURAL GAS

NITROGEN

OXYGEN

PAINT REMOVER - KLEAN STRIP

PCB AROCLOR 1254

PCB TEST SOLUTIONS

- SOLVENT
- RINSE
- REACTION FLUID
- REACTION SOLVENT

PERCHLORETHYLENE

PHOSPHORIC ACID

PLASITE 7122-H EP 56

PROPANE

REFRACTORY - HIGH ALUMINA PLASTIC

REFRIGERANT OIL 150 & 300

REFRIGERANTS

- KAISER 11
- KAISER 22

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MSDS - FIELD AREAS (CONT.)

FREON 11

FREON 12

FREON 13

FREON 22

FREON 500

SALT

SILICATE MORTAR POWDER

SODIUM CHLORIDE

SODIUM SILICATE SOLUTION

S'OK! PENETRATING OIL

SS-25 SOLVENT DEGREASER

STEAM

STEAM CONDENSATE

STEAM & PRESSURE CLEANER (SANO)

STEAM & PRESSURE CLEANER (SOUTHERN)

STEEL

STEEL - BARS, PLATES & PIPES

STEEL - PIPE

STEEL - VALVES, FLANGES & FITTINGS

STERLING U-372 INSULATING VARNISH

SUPER 3000 MORTAR

SULFUR DIOXIDE

SULFURIC ACID

TERGITOL ANIONIC SURFACTANT 4

TERGITOL NONIONIC SURFACTANT 25-L-7

TERGITOL NONIONIC SURFACTANT

THINNER XXX

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MSDS - FIELD AREAS (CONT.)

THINNER NO. 3661 (DUCO)

TITANIUM

TRANSFORMER OIL

TUBULAR SHEATH ELECTRIC HEATER

VARSOL

WEED KILLER

WELDING RODS

WELDING SUPPLIES

- CAST IRON FLUX
- CROMALOY FLUX
- SOLID STEEL WELDING ROD
- SUBMERGED ARC WELDING FLUX
- AIR CARBON ARC GOUGING ELECTRODES
- ANTISPLATTER COMPOUND

WELDWOOD CONTACT CEMENT

XACTSEAL - XYLENE

XYLENE

JUNE 1987

UCC 002446

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CHEMICAL NAME	HFS	HTC		BLDG
ACETONE	342	H3 P2	L0 L1	307
ACETYLENE	144	H7 P1	P2	307
ACETYLENE	144	H7 P1	P2	307
ARGON	201	H7 P0		307
CARBON DIOXIDE	301	P0 P7	L0 L1	307
FREON 13	401	H7		307
FREON 500	401	H7		307
GLYCERINE	111	H7		307
GULFCUT 11D	211	H3	L1	307
GULFCUT 45A	211	H3	H7 L1 P3	307
GULFCUT 80	211	H3	H7 L1 P3	307
HYDROCHLORIC ACID 10%	201	H1	L0 L1	307
ISOPROPANOL 99%	241	H3	L0 L1 P2	307
KAISER 11	161	H7	P0	307
KAISER 22	101	H7	P0	307
METHANOL	341	H3	L0 L1 P2	307
METHYL ETHYL KETONE	341	H3	L0 L1 P3	307
MURATIC ACID	301	H1	L0 L1	307
NAPHTHA	321	P3	L0 L1	307
NITROGEN (COMPRESSED GAS)	111	H7	P0 P9	307
OXYGEN	101	H7	P0	307
PERCHLOROETHYLENE	303	H3	H6 L0 L1	307
PHOSPHORIC ACID	421	H1	L0 L1	307
SALT ROCK	211	H3		307
SODIUM METASILICATE	201	H3	P9	307
STERLING U-372	331	H3	H7 L0 L1 P2	307
SULFURIC ACID	402	H1	L0 L1	307
TERGITOL R 25-LJ	211	H3		307
VARSOL	231	H2	L0 L1	307
VIRGINIA REFR. OIL #150	311	H1	H8	307
VIRGINIA REFR. OIL #300	311	H1	H8	307

UCC 002447

CHEMICAL NAME	HFS	HTC	BLDG
			307
ALUMINA ROHON-POULENC GRADE A	101	H3	30
ALUMINA DESICANT	101	H3	30
CAPACITOR OIL SUNOCO N 185700	222	P3	30
CEMENT SUPER 3000 R&I	201	H3	30
CEMENT, PENCHLOR ACID PROOF	201	H3	30
EPOXY PHENOLIC FINISHES EP-58	341	L0 L1 P2	30
EPOXY PHENOLIC FINISHES EP-85	341	L0 L1 P2	30
EPOXY PHENOLIC FINISHES PLASITE 7100	341	L0 P2	30
GYPSUM PYROFILL	101	H3	30
KEROSENE	321	H3 P3 L0	30
MORTAR, NARCOSET HIGH TEMP	211	H3	30
NAPHTHA V.M &P HIGH INITIAL	321	P3 L0 L1	30
NAPHTHA V.M.&P HIGH INITIAL CODE SD-27	321	P3 L0 L1	30
OIL TRANSFORMER TR-010-N1	211	H3 L0 L1	30
PAINT PLASITE 7122-H	241	H3 P2 L0 L1	30
PERCHLOROETHYLENE	303	H3 H6 L0 L1	30
REFRIGERANT UCON #11	101	H7	30
SALT SAFETY T	211	H3	30
SODIUM CHROMATE	401	H4 H6 L0 L1	30
THINNER CARBOLINE #25 FOR VINYL PAINT	231	H3 H7	30
THINNER DUCO NO. 3881	331	L0 L1 P2	30
THINNER UCC ACM-214 PLASITE # 71	441	H1 H7 L0 L1 P2	30
THINNER UCC T-88 HUMID WEATHER	441	H1 H7 L0 L1 P2	30
TRANSFORMER OIL UCC SPEC TR-010-N1	211	H3 L0 L1	30
VARSOL	231	H2 L0 L1	30
VERMICULITE OR ZONOLITE	211	H3 L0	30
XYLOL UCC CODE 50-28	331	L0 L1 P3	30
XYLOL, INDUSTRIAL	331	L0 L1 P3	30

UCC 002448

CHEMICAL NAME	HFS	HTC	BLDG
ACETONE	343	H3 P2 LO L1	309
BIQUINOLINE	211	H3	309
HYDROGEN PEROXIDE 2%	404	H3 L0 L1 P4 P7	309
HYDROXYLAMINE HYDROCHLORIDE	301	H1	309
NITRIC ACID 1:2	403	H1 L0 L1	309
POTASSIUM FERROCYANIDE 10%	211	H3	309
POTASSIUM THIOCYANATE	201	H3	309
SODIUM ACETATE 20%	101	H3	309
STANNOUS CHLORIDE 10%	201	H3 L1	309

UCC 002449

CHEMICAL NAME	HFS	HTC	BLDG
ACETONE	363	H3 P2 LO L1	309
BIQUINOLINE	211	H3	309
HYDROGEN PEROXIDE 2%	404	H3 L0 L1 P4 P7	309
HYDROXYLAMINE HYDROCHLORIDE	301	H1	309
NITRIC ACID 1:2	403	H1 L0 L1	309
POTASSIUM FERROCYANIDE 10%	211	H3	309
POTASSIUM THIOCYANATE	201	H3	309
SODIUM ACETATE 20%	101	H3	309
STANNOUS CHLORIDE 10%	201	H3 L1	309

UCC 002450

CHEMICAL NAME	HFS	HTC	BLDG
GREASE POLYUREA G2-150-PU			11
LUBE GEAR GULF MULTI-PURPOSE	211	H3 L1	11

UCC 002451

CHEMICAL NAME	HFS	HTC	BLDG
MURATIC ACID	301	H1 L0 L1	224
TERGITOL R 25-L-7	211	H3	224

UCC 002452

CHEMICAL NAME	HFS	HTC	BLDG
CLEANER SKIN WATERLESS SBS-30	101		14
CLEANER STEAM	211	H3	14
OIL CIRCULATING NAPHTALENIC	211	H3 L0 L1	14
OIL CUTTING GULFCUT #45A	211	H3 L0 L1	14
OIL CYLINDER CY-680-CO	211	H3 L0 L1	14
OIL HYDRAULIC HY-032-AW RANDO HD-32	211	H3 L0 L1 P3	14
OIL MIXED FLEET ROTELLA T GRADE 30	211	H3 L0 L1 H3	14
OIL REFRIGERATION RF-068-XX ZERICE 68	211	H0 H1 H3	14
OIL TURBINE LO 81 TU-032-RO	211	H3 L0 L1	14
OIL TURBINE TU-068-RO	211	H3 L0 L1	14
SOLVENT & DEGREASER SS-25	311	H3 L0 L1 P3	14

UCC 002453

CHEMICAL NAME	HFS	HTC	BLDG
DEODORANT CAKE VARIOUS ODORS	101	H3	20

UCC 002454

CHEMICAL NAME	HFS	HTC	BLDG
AIR (COMPRESSED)	111	PO	314

UCC 002455

CHEMICAL NAME	HFS	HTC	BLDG
			521 MC
ACTIVATED CARBON	101	H7 P8	701
ACTIVATED CARBON MESH 8X30	101	H7 P8	701
ADOL 80	212	H3	701
AMBERLITE IR-200	111	H7	701
AMBERLITE IRA-900	111	H7	701
AMINE 270	211	H1	701
BENZOTRIAZOLE	222	H3 P3	701
BIS PHENOL A	211	H3	701
BLENDED COPPER CATALYST	201	H3 H7	701
BORAX, GRANULAR 5 MOL	301	H3	701
BORIC ACID TECH	301	H3	701
CALCIUM CHLORIDE FLAKED	211	H3	701
CAPRIC ACID	212	H3	701
CELATOM FP-4	211	L0 L1 H3	701
CELITE 408 CATALYST	211	L0 L1 H3	701
CELITE 545	211	L1 L0	701
CELITE 577	211	L1 L0 H3	701
CHLOROFORM TECH GRADE	411	H6 L1 L2 L3 L4	701
COPPER POWDER CATALYST	201	H7	701
COPPER SULFATE	201	H3	701
DIMER ACID	211	H3 H7	701
DIPOTASSIUM HYDROXIDE PHOSPHATE	201	L1	701
DISODIUM PHOSPHATE(ANHYD)	111	H3	701
DODECENYL SUCCINIC ANHYDRIDE	211	H3	701
DRY-O-LITE	201	H3	701
EXTRUDED GAMMA ALUMINA	101	H3	701
FILTER GEL	201	H3 L1	701
FILTROL 13	201	H3 L1	701
FILTROL 24 CATALYST MESH 20X60	101	H3 L1	701
GEMTEX SC-75	221	H3	701
HYDROQUINONE	411	H3	701
HYFLO SUPER CEL	301	H3 H7 L0 L1	701
KODA FLEX-DIETHYL PHTHLATE	211	H3	701
MAGNESIUM SILICATE	201	H3 L1 P3	701
MALEIC ANHYDRIDE	411	H1 L1 P3	701
MBT ROTAX POWDERED MCBT	101	H3	701
MONOMETHYLETHER HYDRQ	411	H3	701
MONOTERTBUTYL HYDROQ	311	H3	701
N-OCTYLAMINE	411	H1	701
NAUGUARD 445	211	H3 H7	701
NAUGUARD-P	211	H3 H7	701
NICKEL CATALYST	443	H3 P6	701
OLEIC ACID	111	H7	701
PANA	201	H3	701
PENTANE	341	L0 L1 P2	701
PEP-550	211	H3	701
PHENOTHIAZINE	201	H3 H5 L0 L1	701
PHENYL DIISODEC PHOSPHITE	201	H3	701
PHOSPHORIC ACID 75%	421	H1 L0 L1	701
PICOLINE GAMMA	421	H3 H5	701
POTASSIUM HYDROXIDE(FLAKE)	403	H1 L1	701
POTASSIUM HYDROXIDE(WALNUT)	403	H1 L1	701
POTASSIUM NITRITE	304	H3	701

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CHEMICAL NAME	HFS	HTC	BLDG
			521 N.C.
POTASSIUM SORBATE	303	H3	701
PURIFIED CALCIUM ACETATE	111	H3	701
SAG-470	111	P8	701
SODA ASH	201	H3	701
SODA SORB	201	H3	701
SODIUM BENZOATE	201	H3	701
SODIUM BICARBONATE	202	H3	701
SODIUM NITRATE	202	H3	701
SODIUM NITRITE	301	H3 H5	701
SODIUM SULFITE	202	H3 H4	701
TERT-BUTYL-ALCOHOL	221	H1 L1 P2	701
TERT-BUTYL-PARA-CRESOL BHT	211	H3	701
TERT-BUTYLCATECHOL	414	H1 H5 P7	701
TOLUENE	441	H3 L0 L1 P2	701
TOLYL TRIAZOLE	211	H3	701
TRIBUTYLAMINE	411	H3 L0 L1 P3	701
ZINC CARBONATE BASIC	101	H3	701
ZINC METAL DUST 8 MICRON	101	H3	701

UCC 002457

CHEMICAL NAME	HFS	HTC	BLDG
PHOSPHORIC ACID 75%	421	H1 LO L1	302

UCC 002458

CHEMICAL NAME	HFS	HTC	BLDG
ISOPROPANOL 99%	241	H3 L0 F1 P2	8198
KEROSENE	321	H3 P3 L0	8198
METHYL ETHYL KETONE	341	H3 L0 L1 P3	8198
NAPHTHA	321	P3 L0 L1	8198
XYLENES	331	L0 L1 P3	8198

UCC 002459

CHEMICAL NAME	HFS	HTC	BLDG
FLUROCARBON FS#5	201	H7	02
MERCURY PLUNGER RELAYS	111	L0 L1	02

UCC 002460

CHEMICAL NAME	HFS	HTC	BLDG
MERCURY SWITCHES/INSTRUMENTATION	111	L0 L1	514

UCC 002461

CHEMICAL NAME	HFS	HTC	BLDG
DIESEL FUEL #2	331	P2	428
GASOLINE WHITE	441	L1 P2	428

UCC 002462

CHEMICAL NAME	HFS	HTC	BLDG
ARGON	201	H7 P0	320
GULFCUT 45A	211	H3 H7 L1 P3	320
HELIUM	101	H7 P0	320
ISOPROPANOL 99%	241	H3 L0 L1 P2	320
LAQUER THINNER	331	H0 L0 L1	320
NAPHTHA	321	P3 L0 L1	320
NATURAL GAS	241	P2	320
OXYGEN	101	H7 P0	320
PROPANE GAS	443	P0 P3 P9	320
SODIUM PERSULFATE	202	H3 P7	320

UCC 002463

CHEMICAL NAME	HFS	HTC	BLDG
ACETONE	343	H3 P2 LO L1	318
ARGON	201	H7 P0	319
KEROSENE	321	H3 P3 L0	319

UCC 002464

1910.1045

ACRYLONITRILE

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exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of DBCP.

4. *Blood dyscrasias.* DBCP has been shown to decrease the content of erythrocytes, hemoglobin, and leukocytes in the blood, as well as increase the prothrombin time. Persons with existing blood disorders may be more susceptible to the effects of DBCP.

5. *Reproductive disorders.* Animal studies have associated DBCP with various effects on the reproductive organs. Among these effects are atrophy of the testicles and changes in the estrous cycle. Persons with pre-existing reproductive disorders may be at increased risk to these effects of DBCP.

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(Approved by the Office of Management and Budget under control number 1218-0101)

(Secs. 6, 8, 84 Stat. 1593, 1596, 1599, (29 U.S.C. 655, 657); Secretary of Labor's Order 8-76 (41 FR 25059); (29 CFR 1911; secs. 6(b), 8(c) and 8(g) (84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657), the Secretary of Labor's Order 8-76 (41 FR 25059) and 29 CFR Part 1911, Ch. XVII of Title 29)

[43 FR 11527, Mar. 17, 1978, as amended at 45 FR 35283, May 23, 1980; 49 FR 18295, Apr. 30, 1984]

§ 1910.1045 Acrylonitrile.

(a) *Scope and application.* (1) This section applies to all occupational exposures to acrylonitrile (AN), Chemical Abstracts Service Registry No. 000107131, except as provided in paragraphs (a)(2) and (a)(3) of this section.

(2) This section does not apply to exposures which result solely from the processing, use, and handling of the following materials:

(i) ABS resins, SAN resins, nitrile barrier resins, solid nitrile elastomers, and acrylic and modacrylic fibers, when these listed materials are in the form of finished polymers, and products fabricated from such finished polymers;

(ii) Materials made from and/or containing AN for which objective data is reasonably relied upon to demonstrate that the material is not capable of releasing AN in airborne concentrations in excess of 1 ppm as an eight (8)-hour time-weighted average, under the expected conditions of processing, use, and handling which will cause the greatest possible release; and

(iii) Solid materials made from and/or containing AN which will not be heated above 170° F during handling, use, or processing.

(3) An employer relying upon exemption under paragraph (a)(2)(ii) shall maintain records of the objective data supporting that exemption, and of the basis of the employer's reliance on the data, as provided in paragraph (q) of this section.

(b) *Definitions.* "Acrylonitrile" or "AN" means acrylonitrile monomer, chemical formula $CH_2=CHCN$.

"Action level" means a concentration of AN of 1 ppm as an eight (8)-hour time-weighted average.

"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 specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the opportunity to observe monitoring procedures under paragraph (r) of this section.

"Decontamination" means treatment of materials and surfaces by water washdown, ventilation, or other means, to assure that the materials will not expose employees to airborne concentrations of AN above 1 means the Director, National Institute for

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Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or designee.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, which results in an unexpected massive release of AN.

"Liquid AN" means AN monomer in liquid form, and liquid or semiliquid polymer intermediates, including slurries, suspensions, emulsions, and solutions, produced during the polymerization of AN.

"OSHA Area Office" means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

(c) *Permissible exposure limits*— (1) *Inhalation.* (i) *Time weighted average limit (TWA).* The employer shall assure that no employee is exposed to an airborne concentration of acrylonitrile in excess of two (2) parts acrylonitrile per million parts of air (2 ppm) as an eight (8)-hour time-weighted average.

(ii) *Ceiling limit.* The employer shall assure that no employee is exposed to an airborne concentration of acrylonitrile in excess of ten (10) ppm as averaged over any fifteen (15)-minute period during the work day.

(2) *Dermal and eye exposure.* The employer shall assure that no employee is exposed to skin contact or eye contact with liquid AN.

(d) *Notification of regulated areas and emergencies*— (1) *Regulated areas.* Within thirty (30) days following the establishment of a regulated area pursuant to paragraph (f) of this section, the employer shall report the following information to the OSHA Area Office:

(i) The address and location of each establishment which has one or more regulated areas;

(ii) The locations, within the establishment, of each regulated area;

(iii) A brief description of each process or operation which results in employee exposure to AN in regulated areas; and

(iv) The number of employees engaged in each process or operation within each regulated area which results in exposure to AN, and an estimate of the frequency and degree of exposure that occurs.

Whenever there has been a significant change in the information required to be reported by this paragraph, the employer shall promptly provide the new information to the OSHA Area Office.

(2) *Emergencies.* Emergencies, and the facts obtainable at that time, shall be reported within seventy-two (72) hours of the initial occurrence to the OSHA Area Office. Upon request of the OSHA Area Office, the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of a similar nature.

(e) *Exposure monitoring*—(1) *General.* (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to AN over an eight (8)-hour period.

(ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) *Initial monitoring.* Each employer who has a place of employment in which AN is present shall monitor each such workplace and work operation to accurately determine the airborne concentrations of AN to which employees may be exposed.

(3) *Frequency.* (i) If the monitoring required by this section reveals employee exposure to be below the action level, the employer may discontinue monitoring for that employee.

(ii) If the monitoring required by this section reveals employee exposure to be at or above the action level but below the permissible exposure limits, the employer shall repeat such monitoring for each such employee at least quarterly. The employer shall continue these quarterly measurements until at least two consecutive measurements taken at least seven (7) days apart, are below the action level, and thereafter the employer may discontinue monitoring for that employee.

(iii) If the monitoring required by this section reveals employee exposure to be in excess of the permissible expo-

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sure limits, the employer shall repeat these determinations for each such employee at least monthly. The employer shall continue these monthly measurements until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limits, and thereafter the employer shall monitor at least quarterly.

(4) *Additional monitoring.* Whenever there has been a production, process, control, or personnel change which may result in new or additional exposures to AN, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to AN, additional monitoring which complies with this paragraph shall be conducted.

(5) *Employee notification.* (i) Within five (5) working days after the receipt of the results of monitoring required by this paragraph, the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limits, the employer shall include in the written notice a statement that the permissible exposure limits were exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limits.

(6) *Accuracy of measurement.* The method of measurement of employee exposures shall be accurate to a confidence level of 95 percent, to within plus or minus 35 percent for concentrations of AN at or above the permissible exposure limits, and plus or minus 50 percent for concentrations of AN below the permissible exposure limits.

(f) *Regulated areas.* (1) The employer shall establish regulated areas where AN concentrations are in excess of the permissible exposure limits.

(2) Regulated areas shall be demarcated and segregated from the rest of the workplace, in any manner that minimizes the number of persons who will be exposed to AN.

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

(4) The employer shall assure that food or beverages are not present or consumed, tobacco products are not present or used, and cosmetics are not applied in the regulated area.

(g) *Methods of compliance*—(1) *Engineering and work practice controls.* (i) By November 2, 1980, the employer shall institute engineering and work practice controls to reduce and maintain employee exposures to AN, to or below the permissible exposure limits, except to the extent that the employer establishes that such controls are not feasible.

(ii) Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limits, the employer shall nonetheless use them to reduce exposures to the lowest levels achievable by these controls, and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (h) of this section.

(2) *Compliance program.* (i) The employer shall establish and implement a written program to reduce employee exposures to or below the permissible exposure limits solely by means of engineering and work practice controls, as required by paragraph (g)(1) of this section.

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation or process resulting in employee exposure to AN above the permissible exposure limits;

(B) An outline of the nature of the engineering controls and work practices to be applied to the operation or process in question;

(C) A report of the technology considered in meeting the permissible exposure limits;

(D) A schedule for implementation of engineering and work practice controls for the operation or process, which shall project completion no later than November 2, 1980; and

(E) Other relevant information.

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(iii) The employer shall complete the steps set forth in the compliance program by the dates in the schedule.

(iv) Written plans shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, or any affected employee or representative.

(v) The plans required by this paragraph shall be revised and updated at least every six (6) months to reflect the current status of the program.

(h) *Respiratory protection*—(1) *General.* The employer shall assure that respirators are used where required by this section to reduce employee exposure to within the permissible exposure limits. Respirators shall be used in the following circumstances:

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

(ii) In work operations, such as maintenance and repair activities or reactor cleaning, in which the employer establishes that engineering and work practice controls are not feasible;

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

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respiratory protection is required under this section, the employer shall select and provide, at no cost to the employee, the appropriate type of respirator from table I below, and shall assure that the employee wears the respirator provided.

TABLE I—RESPIRATORY PROTECTION FOR ACRYLONITRILE (AN)

Concentration of AN or condition of use	Respirator type
(a) Less than or equal to 20 ppm	(1) Chemical cartridge respirator with organic vapor cartridge(s) and half mask facepiece, or (2) Supplied air respirator with half mask facepiece
(b) Less than or equal to 100 ppm or maximum use concentration (MUC) of cartridges or canisters, whichever is lower	(1) Full facepiece respirator with (A) organic vapor cartridges, (B) organic vapor gas mask chin style, or (C) organic vapor gas mask canister, front or back-mounted (2) Supplied air respirator with full facepiece, or (3) Self-contained breathing apparatus with full facepiece
(c) Less than or equal to 4,000 ppm	(1) Supplied air respirator operated in the positive pressure mode with full facepiece, helmet, suit, or hood
(d) Greater than 4,000 ppm or unknown concentration.	(1) Supplied air and auxiliary self-contained breathing apparatus with full facepiece in positive pressure mode, or (2) Self-contained breathing apparatus with full facepiece in positive pressure mode
(e) Firefighting	Self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape	(1) Any organic vapor respirator, or (2) Any self-contained breathing apparatus

(ii) The employer shall select respirators from among those approved for use with organic vapors by the National Institute for Occupational Safety and Health under the provisions of 30 CFR part 11.

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

(ii) Where air/purifying respirators (chemical cartridge- or canister-type) are used, the air-purifying canister or cartridge(s) shall be replaced prior to the expiration of their service life or at the completion of each shift, whichever occurs first. A label shall be attached to the cartridge or canister to indicate the date and time at which it is first installed on the respirator.

(iii) *Testing.* Fit testing of respirators shall be performed to assure that the respirator selected provides the protection required by table I.

(A) *Qualitative fit.* The employer shall perform qualitative fit tests at the time of initial fitting and at least semiannually thereafter for each employee wearing respirators.

(B) *Quantitative fit.* Each employer with more than 10 employees wearing

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negative pressure respirators shall perform quantitative fit testing at the time of initial fitting and at least semiannually thereafter for each such employee.

(iv) Employees who wear respirators shall be allowed to wash their faces and to wipe clean the face-to-facepiece seals on their respirators to minimize potential skin irritation associated with respirator use.

(i) *Emergency situations*—(1) *Written plans.* (i) A written plan for emergency situations shall be developed for each workplace where liquid AN is present. Appropriate portions of the plan shall be implemented in the event of an emergency.

(ii) The plan shall specifically provide that employees engaged in correcting emergency conditions shall be equipped as required in paragraph (h) of this section until the emergency is abated.

(iii) Employees not engaged in correcting the emergency shall be evacuated from the area and shall not be permitted to return until the emergency is abated.

(2) *Alerting employees.* Where there is the possibility of employee exposure to AN in excess of the ceiling limit, a general alarm shall be installed and used to promptly alert employees of such occurrences.

(j) *Protective clothing and equipment*—(1) *Provision and use.* Where eye or skin contact with liquid AN may occur, the employer shall provide at no cost to the employee, and assure that employees wear, impermeable protective clothing or other equipment to protect any area of the body which may come in contact with liquid AN. The provision of §§ 1910.132 and 1910.133 shall be complied with.

(2) *Cleaning and replacement.* (i) The employer shall clean, launder, maintain, or replace protective clothing and equipment required by this section as needed to maintain their effectiveness.

(ii) The employer shall assure that impermeable protective clothing which contacts or is likely to have contacted liquid AN shall be decontaminated before being removed by the employee.

(iii) The employer shall assure that an employee whose nonimpermeable clothing becomes wetted with liquid AN shall immediately remove that clothing and proceed to shower. The clothing shall be decontaminated before it is removed from the regulated area.

(iv) The employer shall assure that no employee removes protective clothing or equipment from the change room, except for those employees authorized to do so for the purpose of laundering, maintenance, or disposal.

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

(k) *Housekeeping.* (1) All surfaces shall be maintained free of visible accumulations of liquid AN.

(2) For operations involving liquid AN, the employer shall institute a program for detecting leaks and spills of liquid AN, including regular visual inspections.

(3) Where spills of liquid AN are detected, the employer shall assure that surfaces contacted by the liquid AN are decontaminated. Employees not engaged in decontamination activities shall leave the area of the spill, and shall not be permitted in the area until decontamination is completed.

(l) *Waste disposal.* AN waste, scrap, debris, bags, containers, or equipment shall be decontaminated before being incorporated in the general waste disposal system.

(m) *Hygiene facilities and practices.* (1) Where employees are exposed to airborne concentrations of AN above the permissible exposure limits, or where employees are required to wear protective clothing or equipment pursuant to paragraph (j) of this section, the facilities required by 29 CFR 1910.141, including clean change rooms and shower facilities, shall be provided by the employer for the use of those employees, and the employer shall assure that the employees use the facilities provided.

(2) The employer shall assure that employees wearing protective clothing or equipment for protection from skin contact with liquid AN shall shower at the end of the work shift.

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(3) The employer shall assure that, in the event of skin or eye exposure to liquid AN, the affected employee shall shower immediately to minimize the danger of skin absorption.

(4) The employer shall assure that employees working in the regulated area wash their hands and faces prior to eating.

(n) *Medical surveillance*—(1) *General.* (i) The employer shall institute a program of medical surveillance for each employee who is or will be exposed to AN at or above the action level, without regard to the use of respirators. The employer shall provide each such employee with an opportunity for medical examinations and tests in accordance with this paragraph.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and that they shall be provided without cost to the employee.

(2) *Initial examinations.* At the time of initial assignment, or upon institution of the medical surveillance program, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:

(i) A work history and medical history with special attention to skin, respiratory, and gastrointestinal systems, and those nonspecific symptoms, such as headache, nausea, vomiting, dizziness, weakness, or other central nervous system dysfunctions that may be associated with acute or with chronic exposure to AN;

(ii) A complete physical examination giving particular attention to the peripheral and central nervous system, gastrointestinal system, respiratory system, skin, and thyroid;

(iii) A 14- by 17-inch posteroanterior chest X-ray; and

(iv) Further tests of the intestinal tract, including fecal occult blood screening, for all workers 40 years of age or older, and for any other affected employees for whom, in the opinion of the physician, such testing is appropriate.

(3) *Periodic examinations.* (i) The employer shall provide the examinations specified in paragraph (n)(2) of this section at least annually for all employees specified in paragraph (n)(1) of this section.

(ii) If an employee has not had the examination specified in paragraph (n)(2) of this section within 6 months preceding termination of employment, the employer shall make such examination available to the employee prior to such termination.

(4) *Additional examinations.* If the employee for any reason develops signs or symptoms which may be associated with exposure to AN, the employer shall provide an appropriate examination and emergency medical treatment.

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

(i) A copy of this standard and its appendixes;

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

(iii) The employee's representative exposure level;

(iv) The employee's anticipated or estimated exposure level (for preplacement examinations or in cases of exposure due to an emergency);

(v) A description of any personal protective equipment used or to be used; and

(vi) Information from previous medical examinations of the affected employee, which is not otherwise available to the examining physician.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(A) The results of the medical examination and test performed;

(B) The physician's opinion as to whether the employee has any detected medical condition(s) which would place the employee at an increased risk of material impairment of the employee's health from exposure to AN;

(C) Any recommended limitations upon the employee's exposure to AN or upon the use of protective clothing and equipment such as respirators; and

(D) A statement that the employee has been informed by the physician of the results of the medical examination

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and any medical conditions which require further examination or treatment.

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

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(o) *Employee information and training*—(1) *Training program.* (i) By January 2, 1979, the employer shall institute a training program for and assure the participation of all employees exposed to AN above the action level, all employees whose exposures are maintained below the action level by engineering and work practice controls, and all employees subject to potential skin or eye contact with liquid AN.

(ii) Training shall be provided at the time of initial assignment, or upon institution of the training program, and at least annually thereafter, and the employer shall assure that each employee is informed of the following:

(A) The information contained in appendixes A and B;

(B) The quantity, location, manner of use, release, or storage of AN, and the specific nature of operations which could result in exposure to AN, as well as any necessary protective steps;

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

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

(E) The emergency procedures developed, as required by paragraph (i) of this section;

(F) Engineering and work practice controls, their function, and the employee's relationship to these controls; and

(G) A review of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendixes readily available to all affected employees.

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

(p) *Signs and labels*—(1) *General.* (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph which contradicts or detracts from the required sign or label.

(2) *Signs.* (i) The employer shall post signs to clearly indicate all workplaces where AN concentrations exceed the permissable exposure limits. The signs shall bear the following legend:

DANGER

ACRYLONITRILE (AN)

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

RESPIRATORS MAY BE

REQUIRED

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(3) *Labels.* (i) The employer shall assure that precautionary labels are affixed to all containers of liquid AN and AN-based materials not exempted under paragraph (a)(2) of this standard. The employer shall assure that the lables remain affixed when the materials are sold, distributed, or otherwise leave the employer's workplace.

(ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

DANGER

CONTAINS ACRYLONITRILE (AN)

CANCER HAZARD

(q) *Recordkeeping*—(1) *Objective data for exempted operations.* (i) Where the processing, use, and handling of materials made from or con-

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taining AN are exempted pursuant to paragraph (a)(2)(ii) of this section, the employer shall establish and maintain an accurate record of objective data reasonably relied upon in support of the exemption.

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

(A) The material 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 AN;

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

(E) Other data relevant to the operations, materials, and processing 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 monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.

(ii) This record shall include:

(A) The dates, number, duration, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure;

(B) A description of the sampling and analytical methods used and the data relied upon to establish that the methods used meet the accuracy and precision requirements of paragraph (e)(6) of this section;

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

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for at least forty (40) years, or for the duration of employment plus twenty (20) years, whichever is longer.

(3) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.

(ii) This record shall include:

(A) A copy of the physician's written opinions;

(B) Any employee medical complaints related to exposure to AN;

(C) A copy of the information provided to the physician as required by paragraph (n)(5) of this section; and

(D) A copy of the employee's medical and work history.

(iii) The employer shall assure that this record be maintained for at least forty (40) years, or for the duration of employment plus twenty (20) years, whichever is longer.

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

(ii) Records required by paragraphs (q)(1)-(q)(3) of this section shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (q)-(i). Records required by paragraph (q)(1) shall be provided in the same manner as exposure monitoring records.

(5) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by this section for the prescribed period.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained pursuant to this section, the employer shall notify the Director at least 3 months prior to the disposal of the records, and shall transmit them to the Director upon request.

(iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).

(r) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees, or their designated representatives, an opportunity to observe any monitoring

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of employee exposure to AN conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to AN requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing and equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled:

(A) To receive an explanation of the measurement procedures;

(B) To observe all steps related to the measurement of airborne concentrations of AN performed at the place of exposure; and

(C) To record the results obtained.

(s) *Effective date:* (1) This section shall become effective November 2, 1978.

(2) Monitoring and medical surveillance conducted since January 17, 1978, under the provisions of the emergency temporary standard may be relied upon by the employer to meet the initial monitoring and initial medical surveillance requirements of this section.

(3) Training programs must be implemented by January 2, 1979.

(4) Engineering and work practice controls required by paragraph (g) of this section shall be implemented no later than November 2, 1980.

(t) *Appendixes.* The information contained in the appendixes is not intended, by itself, to create any additional obligation not otherwise imposed, or to detract from any obligation.

APPENDIX A—SUBSTANCE SAFETY DATA SHEET FOR ACRYLONITRILE

I. SUBSTANCE IDENTIFICATION

A. Substance: Acrylonitrile (CH_2 CHCN).

B. Synonyms: Propenenitrile; vinyl cyanide; cyanoethylene; AN; VCN; acylon; carbacryl; fumigrian; ventox.

C. Acrylonitrile can be found as a liquid or vapor, and can also be found in polymer resins, rubbers, plastics, polyols, and other polymers having acrylonitrile as a raw or intermediate material.

D. AN is used in the manufacture of acrylic and modiacrylic fibers, acrylic plastics and resins, speciality polymers, nitrile rubbers, and other organic chemicals. It has also been used as a fumigant.

E. Appearance and odor: Colorless to pale yellow liquid with a pungent odor which can only be detected at concentrations above the permissible exposure level, in a range of 13-19 parts AN per million parts of air (13-19 ppm).

F. Permissible exposure: Exposure may not exceed either:

1. Two parts AN per million parts of air (2 ppm) averaged over the 8-hour workday; or

2. Ten parts AN per million parts of air (10 ppm) averaged over any 15-minute period in the workday.

3. In addition, skin and eye contact with liquid AN is prohibited.

II. HEALTH HAZARD DATA

A. Acrylonitrile can affect your body if you inhale the vapor (breathing), if it comes in contact with your eyes or skin, or if you swallow it. It may enter your body through your skin.

B. Effects of overexposure: 1. Short-term exposure: Acrylonitrile can cause eye irritation, nausea, vomiting, headache, sneezing, weakness, and light-headedness. At high concentrations, the effects of exposure may go on to loss of consciousness and death. When acrylonitrile is held in contact with the skin after being absorbed into shoe leather or clothing, it may produce blisters following several hours of no apparent effect. Unless the shoes or clothing are removed immediately and the area washed, blistering will occur. Usually there is no pain or inflammation associated with blister formation.

2. Long-term exposure: Acrylonitrile has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Repeated or prolonged exposure of the skin to acrylonitrile may produce irritation and dermatitis.

3. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms and suspect they are caused by exposure to acrylonitrile.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye exposure: If acrylonitrile gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

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B. Skin exposure: If acrylonitrile gets on your skin, immediately wash the contaminated skin with water. If acrylonitrile soaks through your clothing, especially your shoes, remove the clothing immediately and wash the skin with water. If symptoms occur after washing, get medical attention immediately. Thoroughly wash the clothing before reusing. Contaminated leather shoes or other leather articles should be discarded.

C. Inhalation: If you or any other person breathes in large amounts of acrylonitrile, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible

D. Swallowing: When acrylonitrile has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

F. Special first aid procedures: First aid kits containing an adequate supply (at least two dozen) of amyl nitrite pearls, each containing 0.3 ml, should be maintained at each site where acrylonitrile is used. When a person is suspected of receiving an overexposure to acrylonitrile, immediately remove that person from the contaminated area using established rescue procedures. Contaminated clothing must be removed and the acrylonitrile washed from the skin immediately. Artificial respiration should be started at once if breathing has stopped. If the person is unconscious, amyl nitrite may be used as an antidote by a properly trained individual in accordance with established emergency procedures. Medical aid should be obtained immediately.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators. You may be required to wear a respirator for nonroutine activities, in emergencies, while your employer is in the process of reducing acrylonitrile exposures through engineering controls, and in areas where engineering controls are not feasible. If respirators are worn, they must have a Mine Safety and Health Administration (MSHA or MESA) or National Institute for Occupational Safety and Health (NIOSH) label of approval for use with organic vapors. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required.

Acrylonitrile does not have a detectable odor except at levels above the permissible exposure limits. Do not depend on odor to warn you when a respirator cartridge or canister is exhausted. Cartridges or canisters must be changed daily or before the end-of-service-life, whichever comes first. Reuse of these may allow acrylonitrille to gradually filter through the cartridge and cause exposures which you cannot detect by odor. If you can smell acrylonitrile while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Supplied-air suits: In some work situations, the wearing of supplied-air suits may be necessary. Your employer must instruct you in their proper use and operation.

C. Protective clothing: You must wear impervious clothing, gloves, face shield, or other appropriate protective clothing to prevent skin contact with liquid acrylonitrile. Where protective clothing is required, your employer is required to provide clean garments to you as necessary to assume that the clothing protects you adequately.

Replace or repair impervious clothing that has developed leaks.

Acrylonitrile should never be allowed to remain on the skin. Clothing and shoes which are not impervious to acrylonitrile should not be allowed to become contaminated with acrylonitrile, and if they do the clothing and shoes should be promptly removed and decontaminated. The clothing should be laundered or discarded after the AN is removed. Once acrylonitrile penetrates shoes or other leather articles, they should not be worn again.

D. Eye protection: You must wear splashproof safety goggles in areas where liquid acrylonitrile may contact your eyes. In addition, contact lenses should not be worn in areas where eye contact with acrylonitrile can occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

A. Acrylonitrile is a flammable liquid, and its vapors can easily form explosive mixtures in air.

B. Acrylonitrile must be stored in tightly closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers (especially bromine), strong bases, copper, copper alloys, ammonia, and amines.

C. Sources of ignition such as smoking and open flames are prohibited wherever acrylonitrile is handled, used, or stored in a

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manner that could create a potential fire or explosion hazard.

D. You should use non-sparking tools when opening or closing metal containers of acrylonitrile, and containers must be bonded and grounded when pouring or transferring liquid acrylonitrile.

E. You must immediately remove any non-impervious clothing that becomes wetted with acrylonitrile, and this clothing must not be reworn until the acrylonitrile is removed from the clothing.

F. Impervious clothing wet with liquid acrylonitrile can be easily ignited. This clothing must be washed down with water before you remove it.

G. If your skin becomes wet with liquid acrylonitrile, you must promptly and thoroughly wash or shower with soap or mild detergent to remove any acrylonitrile from your skin.

H. You must not keep food, beverages, or smoking materials, nor are you permitted to eat or smoke in regulated areas where acrylonitrile concentrations are above the permissible exposure limits.

I. If you contact liquid acrylonitrile, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

J. Fire extinguishers and quick drenching facilities must be readily available, and you should know where they are and how to operate them.

K. Ask your supervisor where acrylonitrile is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for acrylonitrile. In addition, you employer must instruct you in the proper work practices for using acrylonitrile, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to acrylonitrile. 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. If your employer determines that you are being overexposed, he or she is required to inform you of the actions which are being taken to reduce your exposure to within permissible exposure limits.

C. Your employer is required to keep records of your exposures and medical examinations. These records must be kept by the employer for at least forty (40) years or for the period of your employment plus twenty (20) years, whichever is longer.

D. Your employer is required to release your exposure and medical records to you or your representative upon your request.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES FOR ACRYLONITRILE

I. PHYSICAL AND CHEMICAL DATA

A. Substance identification: 1. Synonyms: AN; VCN; vinyl cyanide; propenenitrile; cyanoethylene; Acrylon; Carbacryl; Fumigrain; Ventox.

2. Formula: $CH_2 = CHCN$.

3. Molecular weight: 53.1.

B. Physical data: 1. Boiling point (760 mm Hg): 77.3° C (171° F);

2. Specific gravity (water = 1): 0.81 (at 20° C or 68° F);

3. Vapor density (air = 1 at boiling point of acrylonitrile): 1.83;

4. Melting point: −83° C (−117° F);

5. Vapor pressure (@20° F): 83 mm Hg;

6. Solubility in water, percent by weight @20° C (68° F): 7.35;

7. Evaporation rate (Butyl Acetate = 1): 4.54; and

8. Appearance and odor: Colorless to pale yellow liquid with a pungent odor at concentrations above the permissible exposure level. Any detectable odor of acrylonitrile may indicate overexposure.

II. FIRE, EXPLOSION, AND REACTIVITY HAZARD DATA

A. Fire: 1. Flash point: −1° C (30 °F) (closed cup).

2. Autoignition temperature: 481° C (898° F).

3. Flammable limits air, percent by volume: Lower: 3, Upper: 17.

4. Extinguishing media: Alcohol foam, carbon dioxide, and dry chemical.

5. Special fire-fighting procedures: Do not use a solid stream of water, since the stream will scatter and spread the fire. Use water to cool containers exposed to a fire.

6. Unusual fire and explosion hazards: Acrylonitrile is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard. Acrylonitrile vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which acrylonitrile is being handled.

7. For purposes of compliance with the requirements of 29 CFR 1910.106, acrylonitrile is classified as a class IB flammable liquid. For example, 7,500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.

8. For purposes of compliance with 29 CFR 1910.157, acrylonitrile is classified as a Class B fire hazard.

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9. For purpose of compliance with 29 CFR 1919.309, locations classified as hazardous due to the presence of acrylonitrile shall be Class I, Group D.

B. Reactivity:

1. Conditions contributing to instability: Acrylonitrile will polymerize when hot, and the additional heat liberated by the polymerization may cause containers to explode. Pure AN may self-polymerize, with a rapid build-up of pressure, resulting in an explosion hazard. Inhibitors are added to the commercial product to prevent self-polymerization.

2. Incompatibilities: Contact with strong oxidizers (especially bromine) and strong bases may cause fires and explosions. Contact with copper, copper alloys, ammonia, and amines may start serious decomposition.

3. Hazardous decompostion products: Toxic gases and vapors (such as hydrogen cyanide, oxides of nitrogen, and carbon monoxide) may be released in a fire involving acrylonitrile and certain polymers made from acrylonitrile.

4. Special precautions: Liquid acrylonitrile will attack some forms of plastics, rubbers, and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If acrylonitrile is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.

2. The area should be evacuated at once and re-entered only after the area has been thoroughly ventilated and washed down with water.

3. If liquid acrylonitrile or polymer intermediate, collect for reclamation or absorb in paper, vermiculite, dry sand, earth, or similar material, or wash down with water into process sewer system.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until clean-up has been completed.

C. Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. Spills of acrylonitrile and flushing of such spills shall be channeled for appropriate treatment or collection for disposal. They shall not be channeled directly into the sanitary sewer system. In selecting the method of waste disposal, applicable local, State, and Federal regulations should be consulted.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure above the Permissible Exposure Limit:

1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. Ceiling evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of acrylonitrile in the employee's breathing zone. A minimum of three (3) measurements should be taken on one work shift. The average of all measurements taken is an estimate of the employee's ceiling exposure.

3. Monitoring techniques: The sampling and analysis under this section may be performed by collecting the acrylonitrile vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as real-time continuous monitoring systems, portable direct-reading instruments, or passive dosimeters. Analysis of resultant samples should be by gas chromatograph.

Appendix D lists methods of sampling and analysis which have been tested by NIOSH and OSHA for use with acrylonitrile. NIOSH and OSHA have validated modifications of NIOSH Method S-156 (See Appendix D) under laboratory conditions for concentrations below 1 ppm. The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that methods of monitoring must be accurate, to a 95-percent confidence level, to ±35-percent for concentrations of AN at or above 2 ppm, and to ±-50-percent for concentrations below 2 ppm. In addition to the methods described in Appendix D, there are numerous other methods available for monitoring for AN in the workplace. Details on these other methods have been submitted by various companies to the rulemaking record, and are available at the OSHA Docket Office.

B. Since many of the duties relating to employee exposure are dependent on the results of monitoring and measuring procedures, employers shall assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees shall be provided with and required to wear appropriate protective clothing to prevent any possibility of skin contact with liquid AN. Because acrylonitrile is absorbed through the skin, it is important to prevent skin contact with liquid AN. Protec-

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tive clothing shall include impermeable coveralls or similar full-body work clothing, gloves, head-coverings, as appropriate to protect areas of the body which may come in contact with liquid AN.

Employers should ascertain that the protective garments are impermeable to acrylonitrile. Non-impermeable clothing and shoes should not be allowed to become contaminated with liquid AN. If permeable clothing does become contaminated, it should be promptly removed, placed in a regulated area for removal of the AN, and not worn again until the AN is removed. If leather footwear or other leather garments become wet from acrylonitrile, they should be replaced and not worn again, due to the ability of leather to absorb acrylonitrile and hold it against the skin. Since there is no pain associated with the blistering which may result from skin contact with liquid AN, it is essential that the employee be informed of this hazard so that he or she can be protected.

Any protective clothing which has developed leaks or is otherwise found to be defective shall be repaired or replaced. Clean protective clothing shall be provided to the employee as necessary to assure its protectiveness. Whenever impervious clothing becomes wet with liquid AN, it shall be washed down with water before being removed by the employee. Employees are also required to wear splash-proof safety goggles where there is any possibility of acrylonitrile contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

For purposes of complying with 29 CFR 1910.141, the following items should be emphasized:

A. The workplace should be kept clean, orderly, and in a sanitary condition. The employer is required to institute a leak and spill detection program for operations involving liquid AN in order to detect sources of fugitive AN emissions.

B. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where liquid AN may be found.

C. Adequate washing facilities with hot and cold water are to be provided, and maintained in a sanitary condition. Suitable cleansing agents are also to be provided to assure the effective removal of acrylonitrile from the skin.

D. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with acrylonitrile. Because of the hazardous nature of acrylonitrile, contaminated protective clothing should be placed in a regulated area designated by the employer for removal of the AN before the clothing is laundered or disposed of.

VII. MISCELLANEOUS PRECAUTIONS

A. Store acrylonitrile in tightly-closed containers in a cool, well-ventilated area and take necessary precautions to avoid any explosion hazard.

B. High exposures to acrylonitrile can occur when transferring the liquid from one container to another.

C. Non-sparking tools must be used to open and close metal acrylonitrile containers. These containers must be effectively grounded and bonded prior to pouring.

D. Never store uninhibited acrylonitrile.

E. Acrylonitrile vapors are not inhibited. They may form polymers and clog vents of storage tanks.

F. Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact with and provide respiratory protection from acrylonitrile where the concentration of acrylonitrile is unknown or is above the ceiling limit. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.

G. Employers shall advise employees of all areas and operations where exposure to acrylonitrile could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to acrylonitrile is likely to occur include the following: Manufacture of the acrylonitrile monomer; synthesis of acrylic fibers, ABS, SAN, and nitrile barrier plastics and resins, nitrile rubber, surface coatings, specialty chemicals, use as a chemical intermediate, use as a fumigant and in the cyanoethylation of cotton.

Appendix C—Medical Surveillance Guidelines for Acrylonitrile

I. ROUTE OF ENTRY

Inhalation; skin absorption; ingestion.

II. TOXICOLOGY

Acrylonitrile vapor is an asphyxiant due to inhibitory action on metabolic enzyme systems. Animals exposed to 75 or 100 ppm for 7 hours have shown signs of anoxia; in some animals which died at the higher level, cyanomethemoglobin was found in the blood. Two human fatalities from accidental poisioning have been reported; one was caused by inhalation of an unknown concentration of the vapor, and the other was thought to be caused by skin absorption or inhalation. Most cases of intoxication from industrial exposure have been mild, with rapid onset of eye irritation, headache, sneezing, and nausea. Weakness, lightheadedness, and vomiting may also occur. Expo-

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sure to high concentrations may produce profound weakness, asphyxia, and death. The vapor is a severe eye irritant. Prolonged skin contact with the liquid may result in absorption with systemic effects, and in the formation of large blisters after a latent period of several hours. Although there is usually little or no pain or inflammation, the affected skin resembles a second-degree thermal burn. Solutions spilled on exposed skin, or on areas covered only by a light layer of clothing, evaporate rapidly, leaving no irritation, or, at the most, mild transient redness. Repeated spills on exposed skin may result in dermatitis due to solvent effects.

Results after 1 year of a planned 2-year animal study on the effects of exposure to acrylonitrile have indicated that rats ingesting as little as 35 ppm in their drinking water develop tumors of the central nervous system. The interim results of this study have been supported by a similar study being conducted by the same laboratory, involving exposure of rats by inhalation of acrylonitrile vapor, which has shown similar types of tumors in animals exposed to 80 ppm.

In addition, the preliminary results of an epidemiological study being performed by duPont on a cohort of workers in their Camden, S.C. acrylic fiber plant indicate a statistically significant increase in the incidence of colon and lung cancers among employees exposed to acrylonitrile.

III. SIGNS AND SYMPTOMS OF ACUTE OVEREXPOSURE

Asphyxia and death can occur from exposure to high concentrations of acrylonitrile. Symptoms of overexposure include eye irritation, headache, sneezing, nausea and vomiting, weakness, and light-headedness. Prolonged skin contact can cause blisters on the skin with appearance of a second-degree burn, but with little or no pain. Repeated skin contact may produce scaling dermatits.

IV. TREATMENT OF ACUTE OVEREXPOSURE

Remove employee from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If AN has been swallowed, and person is conscious, induce vomiting. Give artificial resuscitation if indicated. More severe cases, such as those associated with loss of consciousness, may be treated by the intravenous administration of sodium nitrite, followed by sodium thiosulfate, although this is not as effective for acrylonitrile poisoning as for inorganic cyanide poisoning.

V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. As noted above, exposure to acrylonitrile has been linked to increased incidence of cancers of the colon and lung in employees of the duPont acrylic fiber plant in Camden, S.C. In addition, the animal testing of acrylonitrile has resulted in the development of cancers of the central nervous system in rats exposed by either inhalation or ingestion. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to acrylonitrile.

Most reported acute effects of occupational exposure to acrylonitrile are due to its ability to cause tissue anoxia and asphyxia. The effects are similar to those caused by hydrogen cyanide. Liquid acrylonitrile can be absorbed through the skin upon prolonged contact. The liquid readily penetrates leather, and will produce burns of the feet if footwear contaminated with acrylonitrile is not removed.

It is important for the physician to become familiar with the operating conditions in which exposure to acrylonitrile may occur. Those employees with skin diseases may not tolerate the wearing of whatever protective clothing may be necessary to protect them from exposure. In addition, those with chronic respiratory disease may not tolerate the wearing of negative-pressure respirators.

B. Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to acrylonitrile above the action level. The employer must screen employees for history of certain medical conditions which might place the employee at increased risk from exposure.

1. *Central nervous system dysfunction.* Acute effects of exposure to acrylonitrile generally involve the central nervous system. Symptoms of acrylonitrile exposure include headache, nausea, dizziness, and general weakness. The animal studies cited above suggest possible carcinogenic effects of acrylonitrile on the central nervous system, since rats exposed by either inhalation or ingestion have developed similar CNS tumors.

2. *Respiratory disease.* The du Pont data indicate an increased risk of lung cancer among employees exposed to acrylonitrile.

3. *Gastrointestinal disease.* The du Pont data indicate an increased risk of cancer of the colon among employees exposed to acrylonitrile. In addition, the animal studies show possible tumor production in the stomachs of the rats in the ingestion study.

4. *Skin disease.* Acrylonitrile can cause skin burns when prolonged skin contact with the liquid occurs. In addition, repeated skin contact with the liquid can cause dermatitis.

5. *General.* The purpose of the medical procedures outlined in the standard is to establish a baseline for future health monitor-

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ing. Persons unusually susceptible to the effects of anoxia or those with anemia would be expected to be at increased risk. In addition to emphasis on the CNS, respiratory and gastro-intestinal systems, the cardiovascular system, liver, and kidney function should also be stressed.

Appendix D – Sampling and Analytical Methods for Acrylonitrile

There are many methods available for monitoring employee exposures to acrylonitrile. Most of these involve the use of charcoal tubes and sampling pumps, with analysis by gas chromatograph. The essential differences between the charcoal tube methods include, among others, the use of different desorbing solvents, the use of different lots of charcoal, and the use of different equipment for analysis of the samples.

Besides charcoal, considerable work has been performed on methods using porous polymer sampling tubes and passive dosimeters. In addition, there are several portable gas analyzers and monitoring units available on the open market.

This appendix contains details for the methods which have been tested at OSHA Analytical Laboratory in Salt Lake City, and NIOSH in Cincinnati. Each is a variation on NIOSH Method S-156, which is also included for reference. This does not indicate that these methods are the only ones which will be satisfactory. There also may be workplace situations in which these methods are not adequate, due to such factors as high humidity. Copies of the other methods available to OSHA are available in the rulemaking record, and may be obtained from the OSHA Docket Office. These include, the Union Carbide, Monsanto, Dow Chemical and Dow Badische methods, as well as NISOH Method P & CAM 127.

Employers who note problems with sample breakthrough should try larger charcoal tubes. Tubes of larger capacity are available, and are often used for sampling vinyl chloride. In addition, lower flow rates and shorter sampling times should be beneficial in minimizing breakthrough problems.

Whatever method the employer chooses, he must assure himself of the method's accuracy and precision under the unique conditions present in his workplace.

NIOSH Method S-156 (Unmodified)

Analyte: Acrylonitrile.
Matrix: Air.
Procedure: Absorption on charcoal, desorption with methanol, GC.

1. *Principle of the method* (Reference 11.1).

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2 The charcoal in the tube is transferred to a small, stoppered sample container, and the analyte is desorbed with methanol.

1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4 The area of the resulting peak is determined and compared with areas obtained for standards.

2. *Range and sensitivity.*

2.1 This method was validated over the range of 17.5-70.0 mg/cu m at an atmospheric temperature and pressure of 22° C and 760 MM Hg, using a 20-liter sample. Under the conditions of sample size (20-liters) the probable useful range of this method is 4.5-135 mg-cu m. The method is capable of measuring much smaller amounts if the desorption efficiency is adequate. Desorption efficiency must be determined over the range used.

2.2 The upper limit of the range of the method is dependent on the adsorptive capacity of the charcoal tube. This capacity varies with the concentrations of acrylonitrile and other substances in the air. The first section of the charcoal tube was found to hold at least 3.97 mg of acrylonitrile when a test atmosphere containing 92.0 mg/cu m of acrylonitrile in air was sampled 0.18 liter per minute for 240 minutes; at that time the concentration of acrylonitrile in the effluent was less than 5 percent of that in the influent. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam. See section 6.2.) If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

3. *Interference.*

3.1 When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.

3.2 When interfering compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample.

3.3 It must be emphasized that any compound which has the same retention time as the analyte at the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered proof of chemical identity.

3.4 If the possibility of interference exists, separation conditions (column packing, temperature, etc.) must be changed to circumvent the problem.

4. *Precision and accuracy.*

4.1 The Coefficient of Variation (CV_T) for the total analytical and sampling

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method in the range of 17.5-70.0 mg/cu m was 0.073. This value corresponds to a 3.3 mg/cu m standard deviation at the (previous) OSHA standard level (20 ppm). Statistical information and details of the validation and experimental test procedures can be found in Reference 11.2.

4.2 On the average the concentrations obtained at the 20 ppm level using the overall sampling and analytical method were 6.0 percent lower than the "true" concentrations for a limited number of laboratory experiments. Any difference between the "found" and "true" concentrations may not represent a bias in the sampling and analytical method, but rather a random variation from the experimentally determined "true" concentration. Therefore, no recovery correction should be applied to the final result in section 10.5.

5. *Advantages and disadvantages of the method.*

5.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.

The method can also be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions.

5.2 One disadvantage of the method is that the amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

5.3 Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

6. *Apparatus.*

6.1 A calibrated personal sampling pump whose flow can be determined within ±5 percent at the recommended flow rate. (Reference 11.3).

6.2 Charcoal tubes: Glass tubes with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoals prepared from coconut shells and is fired at 600° C prior to packing. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silicated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flow rate of 1 liter per minute.

6.3 Gas chromatograph equipped with a flame ionization detector.

6.4 Column (4-ft × ¼-in stainless steel) packed with 50/80 mesh Poropak, type Q.

6.5 An electronic integrator or some other suitable method for measuring peak areas.

6.6 Two-milliliter sample containers with glass stoppers or Teflon-lined caps. If an automatic sample injector is used, the associated vials may be used.

6.7 Microliter syringes: 10-microliter and other convenient sizes for making standards.

6.8 Pipets: 1.0-ml delivery pipets.

6.9 Volumetric flask: 10-ml or convenient sizes for making standard solutions.

7. *Reagents.*

7.1 Chromatographic quality methanol.

7.2 Acrylonitrile, reagent grade.

7.3 Hexane, reagent grade.

7.4 Purified nitrogen.

7.5 Prepurified hydrogen.

7.6 Filtered compressed air.

8. *Procedure.*

8.1 Cleaning of equipment. All glassware used for the laboratory analysis should be detergent washed and thoroughly rinsed with tap water and distilled water.

8.2 Calibration of personal pumps. Each personal pump must be calibrated with a representative charcoal tube in the line. This will minimize errors associated with uncertainties in the sample volume collected.

8.3 Collection and shipping of samples.

8.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

8.3.2 The smaller section of charcoal is used as a backup and should be positioned nearest the sampling pump.

8.3.3 The charcoal tube should be placed in a vertical direction during sampling to minimize channeling through the charcoal.

8.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

8.3.5 A maximum sample size of 20 liters is recommended. Sample at a flow of 0.20 liter per minute or less. The flow rate should be known with an accuracy of at least ±5 percent.

8.3.6 The temperature and pressure of the atmosphere being sampled should be recorded. If pressure reading is not available, record the elevation.

8.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

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8.3.8 With each batch of 10 samples submit one tube from the same lot of tubes which was used for sample collection and which is subjected to exactly the same handling as the samples except that no air is drawn through it. Label this as a blank.

8.3.9 Capped tubes should be packed tightly and padded before they are shipped to minimize tube breakage during shipping.

8.3.10 A sample of the bulk material should be submitted to the laboratory in a glass container with a Teflon-lined cap. This sample should not be transported in the same container as the charcoal tubes.

8.4 *Analysis of samples.*

8.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

8.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period. If an automatic sample injector is used, the sample vials should be capped as soon as the solvent is added to minimize volatilization.

8.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 50 ml/min (60 psig) nitrogen carrier gas flow.
2. 65 ml/min (24 psig) hydrogen gas flow to detector.
3. 500 ml/min (50 psig) air flow to detector.
4. 235° C injector temperature.
5. 255° C manifold temperature (detector).
6. 155° C column temperature.

8.4.4 Injection. The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, one should employ the solvent flush injection technique. The 10-microliter syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 microliter to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5-microliter aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 microliters to minimize evaporation of the sample from the tip of the needle. Observe that the sample occupies 4.9-5.0 microliters in the barrel of the syringe. Duplicate injections of each sample and standard should be made. No more than a 3 percent difference in area is to be expected. An automatic sample injector can be used if it is shown to give reproducibility at least as good as the solvent flush method.

8.4.5 Measurement of area. The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

8.5 *Determination of desorption efficiency.*

8.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

8.5.2 Procedure for determining desorption efficiency. Activated charcoal equivalent to the amount in the first section of the sampling tube (100 mg) is measured into a 2.5 in. 4-mm I.D. glass tube, flame sealed at one end. This charcoal must be from the same batch as that used in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm. A known amount of hexane solution of acrylonitrile containing 0.239 g/ml is injected directly into the activated charcoal with a microliter syringe, and tube is capped with more Parafilm. When using an automatic sample injector, the sample injector vials, capped with Teflon-faced septa, may be used in place of the glass tube.

The amount injected is equivalent to that present in a 20-liter air sample at the selected level.

Six tubes at each of three levels (0.5X, 1X, and 2X of the standard) are prepared in this manner and allowed to stand for at least overnight to assure complete adsorption of the analyte onto the charcoal. These tubes are referred to as the sample. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube described in section 8.4.

Two or three standards are prepared by injecting the same volume of compound into 1.0 ml of methanol with the same syringe used in the preparation of the samples. These are analyzed with the samples.

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The desorption efficiency (D.E.) equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

$$D.E. = \frac{\text{Average weight recovered (mg)}}{\text{weight added (mg)}}$$

The desorption efficiency is dependent on the amount of analyte collected on the charcoal. Plot the desorption efficiency versus weight of analyte found. This curve is used in section 10.4 to correct for adsorption losses.

9. *Calibration and standards.*

It is convenient to express concentration of standards in terms of mg/1.0 ml methanol, because samples are desorbed in this amount of methanol. The density of the analyte is used to convert mg into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are established by plotting concentration in mg/1.0 ml versus peak area

NOTE.—Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the FID response.

10. *Calculations*

10.1 Read the weight, in mg, corresponding to each peak area from the standard curve. No volume corrections are needed, because the standard curve is based on mg/1.0 ml methanol and the volume of sample injected is identical to the volume of the standards injected.

10.2 Corrections for the bank must be made for each sample.

$$\text{mg} = \text{mg sample} - \text{mg blank}$$

Where:

mg sample = mg found in front section of sample tube.

mg sample = mg found in front section of blank tube.

A similar procedure is followed for the backup sections.

10.3 Add the weights found in the front and backup sections to get the total weight in the sample.

10.4 Read the desorption efficiency from the curve (see sec. 8.5.2) for the amount found in the front section. Divide the total weight by this desorption efficiency to obtain the corrected mg/sample.

$$\text{Corrected mg/sample} = \frac{\text{Total weight}}{\text{D.E.}}$$

10.5 The concentration of the analyte in the air sampled can be expressed in mg/cu m.

$$\text{mg/cu m} = \text{Corrected mg (section 10.4)} \times \frac{1{,}000 \text{ (liter/cu m)}}{\text{air volume sampled (liter)}}$$

10.6 Another method of expressing concentration is ppm.

$$\text{ppm} = \text{m mg/cu} \times 24.45/\text{M.W.} \times 760/P \times T. + 273/298$$

Where:

P = Pressure (mm Hg) of air sampled.

T = Temperature (°C) of air sampled.

24.45 = Molar volume (liter/mole) at 25°C and 760 mm Hg.

M.W. = Molecular weight (g/mole) of analyte.

760 = Standard pressure (mm Hg).

298 = Standard temperature (°K).

11. *References.*

11.1 White, L. D. et al., "A Convenient Optimized Method for the Analysis of Selected Solvent Vapors in the Industrial Atmosphere," *Amer. Ind. Hyg. Assoc. J., 31*:225 (1970).

11.2 Documentation of NIOSH Validation Tests, NIOSH Contract No. CDC-99-74-45.

11.3 Final Report, NIOSH Contract HSM-99-71-31, "Personal Sampler Pump for Charcoal Tubes," September 15, 1972.

NIOSH Modification of NIOSH Method S-156

The NIOSH recommended method for low levels for acrylonitrile is a modification of method S-156. It differs in the following respects:

(1) Samples are desorbed using 1 ml of 1 percent acetone in CS, rather than methanol.

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(2) The analytical column and conditions are:

Column: 20 percent SP-1000 on 80/100 Supelcoport 10 feet x ⅛ inch S.S.

Conditions:

Injector temperature: 200°C.
Detector temperature: 100° C.
Column temperature: 85° C.
Helium flow: 25 ml/min.
Air flow: 450 ml/min.
Hydrogen flow: 55 ml/min.

(3) A 2 μl injection of the desorbed analyte is used.

(4) A sampling rate of 100 ml/min is recommended.

OSHA Laboratory Modification of NIOSH Method S-156

Analyte: Acrylonitrile.
Matrix: Air.
Procedure: Adsorption on charcoal, desorption with methanol, GC.

1. *Principle of the Method* (Reference 1).

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2 The charcoal in the tube is transferred to a small, stoppered sample vial, and the analyte is desorbed with methanol.

1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4 The area of the resulting peak is determined and compared with areas obtained for standards.

2. *Advantages and disadvantages of the method.*

2.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.

2.2 This method may not be adequate for the simultaneous analysis of two or more substances.

2.3 The amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

2.4 The precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

3. *Apparatus.*

3.1 A calibrated personal sampling pump whose flow can be determined within ±5 percent at the recommended flow rate.

3.2 Charcoal tubes: Glass tube with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoal is prepared from coconut shells and is fired at 600° C prior to packing. The adsorbing section contains 100 mg of charcoal, the back-up section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the back-up section. A plug of sililated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than one inch of mercury at a flow rate of 1 liter per minute.

3.3 Gas chromatograph equipped with a nitrogen phosphorus detector.

3.4 Column (10-ft x 1/8"-in stainless steel) packed with 100/120 Supelcoport coated with 10 percent SP 1000.

3.5 An electronic integrator or some other suitable method for measuring peak area.

3.6 Two-milliliter sample vials with Teflon-lined caps.

3.7 Microliter syringes: 10-microliter, and other convenient sizes for making standards.

3.8 Pipets: 1.0-ml delivery pipets.

3.9 Volumetric flasks: convenient sizes for making standard solutions.

4. *Reagents.*

4.1 Chromatographic quality methanol.

4.2 Acrylonitrile, reagent grade.

4.3 Filtered compressed air.

4.4 Purified hydrogen.

4.5 Purified helium.

5. *Procedure.*

5.1 Cleaning of equipment. All glassware used for the laboratory analysis should be properly cleaned and free of organics which could interfere in the analysis.

5.2 Calibration of personal pumps. Each pump must be calibrated with a representative charcoal tube in the line.

5.3 Collection and shipping of samples.

5.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

5.3.2 The smaller section of the charcoal is used as the backup and should be placed nearest the sampling pump.

5.3.3 The charcoal should be placed in a vertical position during sampling to minimize channeling through the charcoal.

5.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

5.3.5 A sample size of 20 liters is recommended. Sample at a flow rate of approximately 0.2 liters per minute. The flow rate should be known with an accuracy of at least ±5 percent.

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5.3.6 The temperature and pressure of the atmosphere being sampled should be recorded.

5.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Rubber caps should not be used.

5.3.8 Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.9. Take necessary shipping and packing precautions to minimize breakage of samples.

5.4 Analysis of samples.

5.4.1 *Preparation of samples.* In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml vial. The separating section of foam is removed and discarded; the section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2 *Desorption of samples.* Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes in an ultrasonic bath. The sample vials are recapped as soon as the solvent is added.

5.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 30 ml/min (60 psig) helium carrier gas flow.
2. 3.0 ml/min (30 psig) hydrogen gas flow to detector.
3. 50 ml/min (60 psig) air flow to detector.
4. 200° C injector temperature.
5. 200° C dejector temperature.
6. 100° C column temperature.

5.4.4 Injection. Solvent flush technique or equivalent.

5.4.5 Measurement of area. The area of the sample peak is measured by an electronic integator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

5.5 Determination of desorption efficiency.

5.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2 Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X (X represents TLV) based on a 20 l air sample are injected onto several tubes at each level. Dilutions of acrylonitrile with methanol are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration they are analyzed following the same procedure as the samples A curve of the desorption efficiency,

amt recovered/amt added

is plotted versus amount of analyte found. This curve is used to correct for adsorption losses.

6. *Calibration and standards.*

A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are prepared by plotting concentration versus peak area.

NOTE.—Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the NPD response. Multiple injections are necessary.

7. *Calculations.*

Read the weight, corresponding to each peak area from the standard curve, correct for the blank, correct for the desorption efficiency, and make necessary air volume corrections.

8. *Reference.* NIOSH Method S-156.

(Secs. 4, 6, 8, 84 Stat. 1592, 1593, 1596, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 8-76 (41 FR 25059); 29 CFR Part 1911; secs. 6(b), 8(c) and 8(g) (84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657), the Secretary of Labor's Order 8-76 (41 FR 25059) and 29 CFR Part 1911, Ch. XVII of Title 29)

[43 FR 45809, Oct. 3, 1978, as amended at 45 FR 35283, May 23, 1980]

§ 1910.1047 Ethylene oxide.

(a) *Scope and application.* (1) This section applies to all occupational exposures to ethylene oxide (EtO), Chemical Abstracts Service Registry No. 75-21-8, except as provided in paragraph (a)(2) of this section.

(2) This section does not apply to the processing, use, or handling of products containing EtO where objective data are reasonably relied upon that demonstrate that the product is not capable of releasing EtO in airborne concentrations at or above the action level under the expected conditions of processing, use, or handling

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1910.1001

ASBESTOS

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Occupational Safety and Health Act of 1970, 84 Stat. 1593, 1597, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 9-83 (48 FR 35736); 29 CFR Part 1911)

[39 FR 23502, June 27, 1974. Redesignated and amended at 40 FR 23073, May 28, 1975; 42 FR 22525, May 3, 1977; 43 FR 2600, Jan. 17, 1978; 43 FR 5963, Feb. 10, 1978; 43 FR 13563, Mar. 31, 1978; 43 FR 19624, May 5, 1978; 43 FR 27394, June 23, 1978; 43 FR 45809, Oct. 3, 1978; 43 FR 53007, Nov. 14, 1978; 43 FR 57602, Dec. 8, 1978; 46 FR 32022, June 19, 1981; 49 FR 25796, June 22, 1984]

§ 1910.1001 Asbestos.

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

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

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

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

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

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

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

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

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

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

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

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

(d) *Personal protective equipment*—(1) Compliance with the exposure

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limits prescribed by paragraph (b) of this section may not be achieved by ie use of respirators or shift rotation of employees, except:

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

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by paragraphs (d)(1) (i), (ii), or (d)(1)(iii) of this section, and both are practicable, personnel rotation shall be preferred and used.

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

(i) *Air purifying respirators.* A reusable or single use air purifying respirator, or a respirator described in paragraph (d)(2) (ii) or (iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) *Powered air purifying respirators.* A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in paragraph (d)(2)(iii) of this section, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

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

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

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

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

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

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

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

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

(*b*) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in paragraph (d)(4)(iii)(*a*) of this section to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

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

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

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

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

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

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

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

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

(g) *Caution signs and labels*—(1) *Caution signs*—(i) *Posting.* Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits pre-

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scribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) *Sign specifications.* The warning signs required by paragraph (g)(1)(i) of this section shall conform to the requirements of 20" x 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	Notation
Asbestos	1" Sans Serif, Gothic or Block
Dust Hazard	3/4" Sans Serif, Gothic or Block
Avoid Breathing Dust	1/4" Gothic
Wear Assigned Protective Equipment	1/4" Gothic
Do Not Remain In Area Unless Your Work Requires It	1/4" Gothic
Breathing Asbestos Dust May Be Hazardous To Your Health	14 point Gothic

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

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

(ii) *Label specifications.* The caution labels required by paragraph (g)(2)(i) of this section shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

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

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

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

(2) *Access.* Employee exposure records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i).

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

(j) *Medical examinations*—(1) *General.* The employer shall provide or

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make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

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

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

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

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

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

(ii) *Access.* Records of the medical examinations required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i). These records shall also be provided upon the request to the Director of NIOSH. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

(k) *Emergency temporary standard effective November 4, 1983*—(1) *Scope.* This emergency temporary standard is issued pursuant to section 6(c) of the Act and applies to all workplaces where employees may be exposed to asbestos in all industries covered by the Act, including, general industry, construction and maritime. Except to the extent modified by this emergency temporary standard all provisions of § 1910.1001 remain in effect.

(2) *Permissible levels of exposure.* The 8-hour time-weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed one-half (0.5) fiber, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Methods of compliance with the emergency temporary standard.* Notwithstanding any other requirements of this section, compliance with the reduced exposure limit of 0.5 f/cc shall be achieved by any feasible combination of engineering controls, work practices, and personal protective equipment and devices.

(4) *Employee information and training*—(i) As soon as possible, but not later than thirty (30) days from the effective date of this emergency temporary standard, the employer shall institute a training program for all employees exposed to airborne concentra-

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tions of asbestos in excess of 0.5 f/cc, without regard to the use of respirators and shall assure their participation in the program during the effective period of this emergency temporary standard.

(ii) The employer shall assure that each such employee is informed of the following:

(A) The health effects associated with asbestos exposure;

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

(C) The nature of operations which could result in exposure to asbestos and necessary protective steps to minimize exposure including, as applicable, engineering controls, work practices, respirators, housekeeping and protective clothing;

(D) The purpose, proper use, fitting instructions and limitations of respirators permitted by the standard; and

(E) A review of all the provisions contained in § 1910.1001.

(5) *Respiratory protection during the ETS.* Notwithstanding any other requirement of this section, where respirators are used to achieve the permissible exposure limit of 0.5 f/cc they shall be selected according to Table 1.

(6) *Warning signs during the ETS.* In addition to the requirements of paragraph (g)(1) of this section, legible signs warning of the health hazards of asbestos shall be provided and displayed at each location where airborne concentrations of asbestos fibers may exceed 0.5 f/cc.

TABLE 1—RESPIRATOR PROTECTION FOR AIRBORNE CONCENTRATIONS OF ASBESTOS

Airborne Concentration of Asbestos (TWA)	Required Respirator [1]
Not in excess of 5 f/cc (10 X PEL)	Reusable or single use air purifying respirator
Not in excess of 50 f/cc (100 X PEL)	Full facepiece air purifying respirator, or a powered air purifying respirator
Greater than 50 f/cc	A type "C" continuous flow or pressure demand, supplied air respirator.

[1] Respirators specified for high concentrations may be used at lower concentrations of asbestos

(Approved by the Office of Management and Budget under control number 1218-0010)

(Secs. 6(b), 8(c) and 8(g) (84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657), the Secretary of Labor's Order 8-76 (41 FR 25059) and 29 CFR Part 1911, Ch. XVII of Title 29; secs. 6(b), 6(c), 8(c) and 8(g), Pub. L. 91-596, 84 Stat. 1593, 1596, 1599, 1600, 29 U.S.C. 655, 657; sec. 107, Pub. L. 91-54, 83 Stat. 96 (40 U.S.C. 333); 29 CFR Part 1911, Secretary of Labor's Order No. 9-83 (48 FR 35736))

[39 FR 23502, June 27, 1974. Redesignated at 40 FR 27073, May 28, 1975, and amended at 41 FR 11505, Mar. 19, 1976; 45 FR 35281, May 23, 1980; 48 FR 51139, Nov. 4, 1983; 49 FR 18295, Apr. 30, 1984]

§ 1910.1002 Coal tar pitch volatiles; interpretation of term.

As used in § 1910.1000 (Table Z-1), coal tar pitch volatiles include the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum (excluding asphalt), wood, and other organic matter. Asphalt (CAS 8052-42-4, and CAS 64742-93-4) is not covered under the "coal tar pitch volatiles" standard.

[48 FR 2768, Jan. 21, 1983]

§ 1910.1003 4-Nitrobiphenyl.

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

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

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

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

(3) "Clean change room" means a room where employees put on clean clothing and/or protective equipment in an environment free of 4-Nitrobiphenyl. The clean change room shall be contiguous to and have an entry

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1910.1047

ETHYLENE OXIDE

UCC 002493

5.3.6 The temperature and pressure of the atmosphere being sampled should be recorded.

5.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Rubber caps should not be used.

5.3.8 Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.9. Take necessary shipping and packing precautions to minimize breakage of samples.

5.4 Analysis of samples.

5.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml vial. The separating section of foam is removed and discarded; the section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes in an ultrasonic bath. The sample vials are recapped as soon as the solvent is added.

5.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 30 ml/min (60 psig) helium carrier gas flow.
2. 3.0 ml/min (30 psig) hydrogen gas flow to detector.
3. 50 ml/min (60 psig) air flow to detector.
4. 200° C injector temperature.
5. 200° C dejector temperature.
6. 100° C column temperature.

5.4.4 Injection. Solvent flush technique or equivalent.

5.4.5 Measurement of area. The area of the sample peak is measured by an electronic integator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

5.5 Determination of desorption efficiency.

5.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2 Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X (X represents TLV) based on a 20 l air sample are injected onto several tubes at each level. Dilutions of acrylonitrile with methanol are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration they are analyzed following the same procedure as the samples A curve of the desorption efficiency.

amt recovered/amt added

is plotted versus amount of analyte found. This curve is used to correct for adsorption losses.

6. *Calibration and standards.*

A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are prepared by plotting concentration versus peak area.

NOTE.—Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the NPD response. Multiple injections are necessary.

7. *Calculations.*

Read the weight, corresponding to each peak area from the standard curve, correct for the blank, correct for the desorption efficiency, and make necessary air volume corrections.

8. *Reference.* NIOSH Method S-156.

(Secs. 4, 6, 8, 84 Stat. 1592, 1593, 1596, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 8-76 (41 FR 25059); 29 CFR Part 1911; secs. 6(b), 8(c) and 8(g) (84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657), the Secretary of Labor's Order 8-76 (41 FR 25059) and 29 CFR Part 1911, Ch. XVII of Title 29)

[43 FR 45809, Oct. 3, 1978, as amended at 45 FR 35283, May 23, 1980]

§ 1910.1047 Ethylene oxide.

(a) *Scope and application.* (1) This section applies to all occupational exposures to ethylene oxide (EtO), Chemical Abstracts Service Registry No. 75-21-8, except as provided in paragraph (a)(2) of this section.

(2) This section does not apply to the processing, use, or handling of products containing EtO where objective data are reasonably relied upon that demonstrate that the product is not capable of releasing EtO in airborne concentrations at or above the action level under the expected conditions of processing, use, or handling

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that will cause the greatest possible release.

(3) Where products containing EtO are exempted under paragraph (a)(2) of this section, the employer shall maintain records of the objective data supporting that exemption and the basis for the employer's reliance on the data, as provided in paragraph (k)(1) of this section.

(b) *Definitions:* For the purpose of this section, the following definitions shall apply:

"Action level" means a concentration of airborne EtO of 0.5 ppm calculated as an eight (8)-hour time-weighted average.

"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 specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph (l) of this section, or any other person authorized by the Act or regulations issued under the Act.

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

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that is likely to or does result in an unexpected significant release of EtO.

"Employee exposure" means exposure to airborne EtO which would occur if the employee were not using respiratory protective equipment.

"Ethylene oxide" or *"EtO"* means the three-membered ring organic compound with chemical formula C_2H_4O.

(c) *Permissible exposure limits (PEL)—8-hour time-weighted average (TWA).* The employer shall ensure that no employee is exposed to an airborne concentration of EtO in excess of one (1) part EtO per million parts of air (1 ppm) as an eight (8)-hour time-weighted average (8-hour TWA).

(d) *Exposure monitoring*—(1) *General.* (i) Determinations of employee exposure shall be made from breathing zone air samples that are representative of the 8-hour TWA of each employee.

(ii) Representative 8-hour TWA employee exposure shall be determined on the basis of one or more samples representing full-shift exposure for each shift for each job classification in each work area.

(iii) Where the employer can document that exposure levels are equivalent for similar operations in different work shifts, the employer need only determine representative employee exposure for that operation during one shift.

(2) *Initial monitoring.* (i) Each employer who has a workplace or work operation covered by this standard, except as provided for in paragraph (a)(2) or (d)(2)(ii) of this section, shall perform initial monitoring to determine accurately the airborne concentrations of EtO to which employees may be exposed.

(ii) Where the employer has monitored after June 15, 1983 and the monitoring satisfies all other requirements of this section, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraph (d)(2)(i) of this section.

(3) *Monitoring frequency (periodic monitoring).* (i) If the monitoring required by paragraph (d)(2) of this section reveals employee exposure at or above the action level but at or below the 8-hour TWA, the employer shall repeat such monitoring for each such employee at least every 6 months.

(ii) If the monitoring required by paragraph (d)(2)(i) of this section reveals employee exposure above the 8-hour TWA, the employer shall repeat such monitoring for each such employee at least every 3 months.

(iii) The employer may alter the monitoring schedule from quarterly to semiannually for any employee for whom two consecutive measurements taken at least 7 days apart indicate that the employee's exposure has decreased to or below the 8-hour TWA.

(4) *Termination of monitoring.* (i) If the initial monitoring required by paragraph (d)(2)(i) of this section re-

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veals employee exposure to be below the action level, the employer may discontinue the monitoring for those employees whose exposures are represented by the initial monitoring.

(ii) If the periodic monitoring required by paragraph (d)(3) of this section reveals that employee exposures, as indicated by at least two consecutive measurements taken at least 7 days apart, are below the action level, the employer may discontinue the monitoring for those employees whose exposures are represented by such monitoring.

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

(6) *Accuracy of monitoring.* Monitoring shall be accurate, to a confidence level of 95 percent, to within plus or minus 25 percent for airborne concentrations of EtO at the 1 ppm TWA and to within plus or minus 35 percent for airborne concentrations of EtO at the action level of 0.5 ppm.

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

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

(e) *Regulated Areas.* (1) The employer shall establish a regulated area wherever occupational exposures to airborne concentrations of EtO may exceed the TWA.

(2) Access to regulated areas shall be limited to authorized persons.

(3) Regulated areas shall be demarcated in any manner that minimizes the number of employees within the regulated area.

(f) *Methods of compliance.* (1) *Engineering controls and work practices.* (i) The employer shall institute engineering controls and work practices to reduce and maintain employee exposure to or below the TWA, except to the extent that such controls are not feasible.

(ii) Wherever the feasible engineering controls and work practices that can be instituted are not sufficient to reduce employee exposure to or below the TWA, the employer shall use them to reduce employee exposure to the lowest levels achievable by these controls and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (g) of this section.

(iii) Engineering controls are generally infeasible for the following operations: collection of quality assurance sampling from sterilized materials removal of biological indicators from sterilized materials; loading and unloading of tank cars; changing of ethylene oxide tanks on sterilizers; and vessel cleaning. For these operations, engineering controls are required only where the Assistant Secretary demonstrates that such controls are feasible.

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

(ii) The compliance program shall include a schedule for periodic leak detection surveys and a written plan for emergency situations, as specified in paragraph (h)(i) of this section.

(iii) Written plans for a program required in paragraph (f)(2) shall be developed and furnished upon request for examination and copying to the Assistant Secretary, the Director, affected employees and designated employee representatives. Such plans

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shall be reviewed at least every 12 months, and shall be updated as necessary to reflect significant changes in the status of the employer's compliance program.

(iv) The employer shall not implement a schedule of employee rotation as a means of compliance with the TWA.

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

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

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

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

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide, at no cost to the employee, the appropriate respirator as specified in Table 1, 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 against EtO by the Mine Safety and Health Administration (MSHA) and by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

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

(4) *Protective clothing and equipment.* Where eye or skin contact with liquid EtO or EtO solutions may occur, the employer shall select and provide, at no cost to the employee, appropriate protective clothing or other equipment in accordance with 29 CFR 1901.132 and 1910.133 to protect any area of the body that may come in contact with liquid EtO or EtO in solution, and shall ensure that the employee wears the protective clothing and equipment provided.

(h) *Emergency situations.* (1) *Written plan.* (i) A written plan for emergency situations shall be developed for each workplace where there is a possibility of an emergency. Appropriate portions of the plan shall be implemented in the event of an emergency.

(ii) The plan shall specifically provide that employees engaged in correcting emergency conditions shall be equipped with respiratory protection as required by paragraph (g) of this section until the emergency is abated.

(iii) The plan shall include the elements prescribed in 29 CFR 1910.38, "Employee emergency plans and fire prevention plans."

(2) *Alerting employees.* Where there is the possibility of employee exposure to EtO due to an emergency, means shall be developed to alert potentially affected employees of such occurrences promptly. Affected employees shall be immediately evacuated from the area in the event that an emergency occurs.

TABLE 1—MINIMUM REQUIREMENTS FOR RESPIRATORY PROTECTION FOR AIRBORNE ETO

Condition of use or concentration of airborne EtO (ppm)	Minimum required respirator
Equal to or less than 50.	(a) Full facepiece respirator with EtO approved canister, front-or back-mounted.
Equal to or less than 2,000.	(a) Positive-pressure supplied air respirator, equipped with full facepiece, hood, or helmet, or (b) Continuous-flow supplied air respirator (positive pressure) equipped with hood, helmet or suit.
Concentration above 2,000 or unknown concentration (such as in emergencies)	(a) Positive-pressure self-contained breathing apparatus (SCBA), equipped with full facepiece, or (b) Positive-pressure full facepiece supplied air respirator equipped with an auxiliary positive-pressure self-contained breathing apparatus.
Firefighting	(a) Positive pressure self-contained breathing apparatus equipped with full facepiece.
Escape	(a) Any respirator described above

Note.—Respirators approved for use in higher concentrations are permitted to be used in lower concentrations

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(i) *Medical Surveillance—General—* (1) *Employees covered.* (A) The employer shall institute a medical surveillance program for all employees who are or may be exposed to EtO at or above the action level, without regard to the use of respirators, for at least 30 days a year.

(B) The employer shall make available medical examinations and consultations to all employees who have been exposed to EtO in an emergency situation.

(ii) *Examination by a physician.* The employer shall ensure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided without cost to the employee, without loss of pay, and at a reasonable time and place.

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

(A) Prior to assignment of the employee to an area where exposure may be at or above the action level for at least 30 days a year.

(B) At least annually each employee exposed at or above the action level for at least 30 days in the past year.

(C) At termination of employment or reassignment to an area where exposure to EtO is not at or above the action level for at least 30 days a year.

(D) As medically appropriate for any employee exposed during an emergency.

(E) As soon as possible, upon notification by an employee either (1) that the employee has developed signs or symptoms indicating possible overexposure to EtO, or (2) that the employee desires medical advice concerning the effects of current or past exposure to EtO on the employee's ability to produce a healthy child.

(F) 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 recommended by the physician.

(ii) *Content.* (A) Medical examinations made available pursuant to paragraphs (i)(2)(i)(A)-(D) of this section shall include:

(*1*) A medical and work history with special emphasis directed to symptoms related to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(*2*) A physical examination with particular emphasis given to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(*3*) A complete blood count to include at least a white cell count (including differential cell count), red cell count, hematocrit, and hemoglobin.

(*4*) Any laboratory or other test which the examining physician deems necessary by sound medical practice.

(B) The content of medical examinations or consultation made available pursuant to paragraph (i)(2)(i)(E) of this section shall be determined by the examining physician, and shall include pregnancy testing or laboratory evaluation of fertility, if requested by the employee and deemed appropriate by the 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 A, B, and C.

(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.

(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

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the employee at an increased risk of material health impairment from exposure to EtO;

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

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

(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 EtO.

(iii) The employer shall provide a copy of the physician's written opinion to the affected employee within 15 days from its receipt.

(j) *Communication of EtO hazards to employees.* (1) *Signs and labels.* (i) The employer shall post and maintain legible signs demarcating regulated areas and entrances or accessways to regulated areas that bear the following legend:

DANGER
ETHYLENE OXIDE
CANCER HAZARD AND REPRODUCTIVE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING MAY BE REQUIRED TO BE WORN IN THIS AREA

(ii) The employer shall ensure that precautionary labels are affixed to all containers of EtO whose contents are capable of causing employee exposure at or above the action level, and that the labels remain affixed when the containers of EtO leave the workplace. For the purposes of this paragraph, reaction vessels, storage tanks, and pipes or piping systems are not considered to be containers. The labels shall comply with the requirements of 29 CFR 1910.1200(f) of OSHA's Hazard Communication standard, and shall include the following legend:

(A) CAUTION
CONTAINS ETHYLENE OXIDE
CANCER AND REPRODUCTIVE HAZARD;

and

(B) A warning statement against breathing airborne concentrations of EtO.

(2) *Material safety data sheets.* Employers who are manufacturers or importers of EtO shall comply with the requirements regarding development of material safety data sheets as specified in 29 CFR 1910.1200(g) of OSHA's Hazard Communication standard.

(3) *Information and training.* (i) The employer shall provide employees who are potentially exposed to EtO at or above the action level with information and training on EtO at the time of initial assignment and at least annually thereafter.

(ii) Employees shall be informed of the following:

(A) The requirements of this section with an explanation of its contents, including Appendices A and B;

(B) Any operations in their work area where EtO is present;

(C) The location and availability of the written EtO final rule; and

(D) The medical surveillance program required by paragraph (i) of this section with an explanation of the information in Appendix C.

(iii) Employee training shall include at least:

(A) Methods and observations that may be used to detect the presence or release of EtO in the work area (such as monitoring conducted by the employer, continuous monitoring devices, etc.);

(B) The physical and health hazards of EtO;

(C) The measures employees can take to protect themselves from hazards associated with EtO exposure, including specific procedures the employer has implemented to protect employees from exposure to EtO, such as work practices, emergency procedures, and personal protective equipment to be used; and

(D) The details of the hazard communication program developed by the employer, including an explanation of the labeling system and how employees can obtain and use the appropriate hazard information.

(k) *Recordkeeping*—(1) *Objective data for exempted operations.*

(i) Where the processing, use, or handling of products made from or

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containing EtO are exempted from other requirements of this section under paragraph (a)(2) of this section, or where objective data have been relied on in lieu of initial monitoring under paragraph (d)(2)(ii) of this section, the employer shall establish and maintain an accurate record of objective data reasonably relied upon in support of the exemption.

(ii) This 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 EtO;

(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 EtO as prescribed in paragraph (d) of this section.

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

(A) The date of measurement;

(B) The operation involving exposure to EtO which 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 (i)(1)(i) of this section, in accordance with 29 CFR 1910.20.

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

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

(B) Physicians' written opinions;

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

(D) A copy of the information provided to the physician as required by paragraph (i)(3) 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) *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 exemption and exposure records required by paragraphs (k) (1) and (2) 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 paragraph (k)(3) 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.

(5) *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 transmit them to the Director.

(l) *Observation of monitoring.* (1) *Employee observation.*

The employer shall provide affected employees or their designated representatives an opportunity to observe

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any monitoring of employee exposure to EtO conducted in accordance with paragraph (d) of this section.

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

(m) *Dates*—(1) *Effective date.* The paragraphs contained in this section shall become effective August 21, 1984, except for paragraphs (a)(2), (d), (e), (f)(2), (g)(3), (h), (i), and (j) which shall become effective on March 12, 1985.

(2) *Start-up dates.* (i) The start-up date for the requirements in those paragraphs that were effective on August 21, 1984, including institution of work practice controls specified in paragraph (f)(1), shall be February 19, 1985, except as provided for in paragraph (m)(2)(ii), and the start-up date for paragraphs (a)(2), (d), (e), (f)(2), (g)(3), (h), (i), and (j) of this section shall be September 9, 1985.

(ii) Engineering controls specified by paragraph (f)(1) of this section shall be implemented by August 21, 1985.

(n) *Appendices.* The information contained in the appendices is not intended by itself to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Appendix A—Substance Safety Data Sheet for Ethylene Oxide

I. Substance Identification

A. Substance: Ethylene oxide (C_2H_4O).

B. Synonyms: dihydrooxirene, dimethylene oxide, EO, 1,2-epoxyethane, EtO, ETO, oxacyclopropane, oxane, oxidoethane, alpha/beta-oxidoethane, oxiran, oxirane.

C. Ethylene oxide can be found as a liquid or vapor.

D. EtO is used in the manufacture of ethylene glycol, surfactants, ethanolamines, glycol ethers, and other organic chemicals. EtO is also used as a sterilant and fumigant.

E. Appearance and odor: Colorless liquid below 10.7 °C (51.3 °F) or colorless gas with ether-like odor detected at approximately 700 parts EtO per million parts of air (700 ppm).

F. Permissible exposure: Exposure may not exceed 1 part EtO per million parts of air averaged over the 8-hour work day, nor may short-term exposure exceed 10 parts of EtO per million parts of air averaged over a 15 minute period.

II. Health Hazard Data

A. Ethylene oxide can cause bodily harm if you inhale the vapor, if it comes into contact with your eyes or skin, or if you swallow it.

B. Effects of overexposure:

1. Ethylene oxide in liquid form can cause eye irritation and injury to the cornea, frostbite, and severe irritation and blistering of the skin upon prolonged or confined contact. Ingestion of EtO can cause gastric irritation and liver injury. Acute effects from inhalation of EtO vapors include respiratory irritation and lung injury, headache, nausea, vomiting, diarrhea, shortness of breath, and cyanosis (blue or purple coloring of skin). Exposure has also been associated with the occurrence of cancer, reproductive effects, mutagenic changes, neurotoxicity, and sensitization.

1. EtO has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Adverse reproductive effects and chromosome damage may also occur from EtO exposure.

a. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to EtO.

III. Emergency First Aid Procedures

A. Eye exposure: If EtO gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper eyelids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

B. Skin exposure: If EtO gets on your skin, immediately wash the contaminated skin with water. If EtO soaks through your clothing, especially your shoes, remove the clothing immediately and wash the skin with water using an emergency deluge shower. Get medical attention immediately. Thoroughly wash contaminated clothing before reusing. Contaminated leather shoes or other leather articles should not be reused and should be discarded.

C. Inhalation: If large amounts of EtO are inhaled, the exposed person must be moved to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation. Keep the affected person warm and at rest. Get medical attention immediately.

D. Swallowing: When EtO has been swallowed, give the person large quantities of water immediately. After the water has

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been swallowed, try to get the person to vomit by having him or her touch the back of the throat with his or her finger. Do not make an unconscious person vomit. Get medical attention immediately.

E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, attempt rescue only after notifying at least one other person of the emergency and putting into effect established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.

IV. Respirators and Protective Clothing

A. Respirators: You may be required to wear a respirator for nonroutine activities, in emergencies, while your employer is in the process of reducing EtO exposures through engineering controls, and where engineering controls are not feasible. As of the effective date of the standard, only air supplied positive-pressure, full-facepiece respirators are approved for protection against EtO. If air-purifying respirators are worn in the future, they must have a joint Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH) label of approval for use with ethylene oxide. For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where their use is required.

EtO does not have a detectable odor except at levels well above the permissible exposure limits. If you can smell EtO while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective clothing: You may be required to wear impermeable clothing, gloves, a face shield, or other appropriate protective clothing to prevent skin contact with liquid EtO or EtO-containing solutions. Where protective clothing is required, your employer must provide clean garments to you as necessary to assure that the clothing protects you adequately.

Replace or repair protective clothing that has become torn or otherwise damaged.

EtO must never be allowed to remain on the skin. Clothing and shoes which are not impermeable to EtO should not be allowed to become contaminated with EtO, and if they do, the clothing should be promptly removed and decontaminated. Contaminated leather shoes should be discarded. Once EtO penetrates shoes or other leather articles, they should not be worn again.

C. Eye protection: You must wear splash-proof safety goggles in areas where liquid EtO or EtO-containing solutions may contact your eyes. In addition, contact lenses should not be worn in areas where eye contact with EtO can occur.

V. Precautions for Safe Use, Handling, and Storage

A. EtO is a flammable liquid, and its vapors can easily form explosive mixtures in air.

B. EtO must be stored in tightly closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers, alkalines, and acids, strong bases, acetylide-forming metals such as cooper, silver, mercury and their alloys.

C. Sources of ignition such as smoking material, open flames and some electrical devices are prohibited wherever EtO is handled, used, or stored in a manner that could create a potential fire or explosion hazard.

D. You should use non-sparking tools when opening or closing metal containers of EtO, and containers must be bonded and grounded in the rare instances in which liquid EtO is poured or transferred.

E. Impermeable clothing wet with liquid EtO or EtO-containing solutions may be easily ignited. If your are wearing impermeable clothing and are splashed with liquid EtO or EtO-containing solution, you should immediately remove the clothing while under an emergency deluge shower.

F. If your skin comes into contact with liquid EtO or EtO-containing solutions, you should immediately remove the EtO using an emergency deluge shower.

G. You should not keep food, beverages, or smoking materials in regulated areas where employee exposures are above the permissible exposure limits.

H. Fire extinguishers and emergency deluge showers for quick drenching should be readily available, and you should know where they are and how to operate them.

I. Ask your supervisor where EtO is used in your work area and for any additional plant safety and health rules.

VI. Access to Information

A. Each year, your employer is required to inform you of the information contained in this standard and appendices for EtO. In addition, your employer must instruct you in the proper work practices for using EtO emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to EtO. 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. If your employer determine that you are being overexposed, he or she is required to inform

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you of the actions which are being taken to reduce your exposure to within permissible exposure limits.

C. Your employer is required to keep records of your exposures and medical examinations. These exposure records must be kept by the employer 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.

VII. Sterilant Use of EtO in Hospitals and Health Care Facilities

This section of Appendix A, for informational purposes, sets forth EPA's recommendations for modifications in workplace design and practice in hospitals and health care facilities for which the Environmental Protection Agency has registered EtO for uses as a sterilant or fumigant under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. 136 *et seq.* These new recommendations, published in the Federal Register by EPA at 49 FR 15268, as modified in today's Register, are intended to help reduce the exposure of hospital and health care workers to EtO to 1 ppm. EPA's recommended workplace design and workplace practice are as follows:

1. Workplace Design

a. *Installation of gas line hand valves.* Hand valves must be installed on the gas supply line at the connection to the supply cylinders to minimize leakage during cylinder change.

b. *Installation of capture boxes.* Sterilizer operations result in a gas/water discharge at the completion of the process. This discharge is routinely piped to a floor drain which is generally located in an equipment or an adjacent room. When the floor drain is not in the same room as the sterilizer and workers are not normally present, all that is necessary is that the room be well ventilated.

The installation of a "capture box" will be required for those work place layouts where the floor drain is located in the same room as the sterilizer or in a room where workers are normally present. A "capture box" is a piece of equipment that totally encloses the floor drain where the discharge from the sterilizer is pumped. The "capture box" is to be vented directly to a non-recirculating or dedicated ventilation system. Sufficient air intake should be allowed at the bottom of the box to handle the volume of air that is ventilated from the top of the box. The "capture box" can be made of metal, plastic, wood or other equivalent material. The box is intended to reduce levels of EtO discharged into the work room atmosphere. The use of a "capture box" is not required if: (1) The vacuum pump discharge floor drain is located in a well ventilated equipment or other room where workers are not normally present or (2) the water sealed vacuum pump discharges directly to a closed sealed sewer line (check local plumbing codes).

If it is impractical to install a vented "capture box" and a well ventilated equipment or other room is not feasible, a box that can be sealed over the floor drain may be used if: (1) The floor drain is located in a room where workers are not normally present and EtO cannot leak into an occupied area, and (2) the sterilizer in use is less than 12 cubic feet in capacity (check local plumbing codes).

c. *Ventilation of aeration units* i. *Existing aeration units.* Existing units must be vented to a non-recirculating or dedicated system or vented to an equipment or other room where workers are not normally present and which is well ventilated. Aerator units must be positioned as close as possible to the sterilizer to minimize the exposure from the off-gassing of sterilized items.

ii. *Installation of new aerator units (where none exist).* New aerator units must be vented as described above for existing aerators. Aerators must be in place by July 1, 1986.

d. *Ventilation during cylinder change.* Workers may be exposed to short but relatively high levels of EtO during the change of gas cylinders. To reduce exposure from this route, users must select one of three alternatives designed to draw off gas that may be released when the line from the sterilizer to the cylinder is disconnected:

i. Location of cylinders in a well ventilated equipment room or other room where workers are not normally present.

ii. Installation of a flexible hose (at least 4" in diameter) to a non-recirculating or dedicated ventilation system and located in the area of cylinder change in such a way that the hose can be positioned at the point where the sterilizer gas line is disconnected from the cylinder.

iii. Installation of a hood that is part of a non-recirculating or dedicated system and positioned no more than one foot above the point where the change of cylinders takes place.

e. *Ventilation of sterilizer door area.* One of the major sources of exposure to EtO occurs when the sterilizer door is opened following the completion of the sterilization process. In order to reduce this avenue of exposure, a hood or metal canopy closed on each end must be installed over the sterilizer door. The hood or metal canopy must be connected to a non-recirculating or dedicated ventilation system or one that exhausts

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gases to a well ventilated equipment or other room where workers are not normally present. A hood or canopy over the sterilizer door is required for use even with those sterilizers that have a purge cycle and must be in place by July 1, 1986.

f. *Ventilation of sterilizer relief valve.* Sterilizers are typically equipped with a safety relief device to release gas in case of increased pressure in the sterilizer. Generally, such relief devices are used on pressure vessels. Although these pressure relief devices are rarely opened for hospital and health care sterilizers, it is suggested that they be designed to exhaust vapor from the sterilizer by one of the following methods:

i. Through a pipe connected to the outlet of the relief valve ventilated directly outdoors at a point high enough to be away from passers by, and not near any windows that open, or near any air conditioning or ventilation air intakes.

ii. Through a connection to an existing or new non-recirculating or dedicated ventilation system.

iii. Through a connection to a well ventilated equipment or other room where workers are not normally present.

g. *Ventilation systems.* Each hospital and health care facility affected by this notice that uses EtO for the sterilization of equipment and supplies must have a ventilation system which enables compliance with the requirements of section (b) through (f) in the manner described in these sections and within the timeframes allowed. Thus, each affected hospital and health care facility must have or install a non-recirculating or dedicated ventilation equipment or other room where workers are not normally present in which to vent EtO.

h. *Installation of alarm systems.* An audible and visual indicator alarm system must be installed to alert personnel of ventilation system failures, i.e., when the ventilation fan motor is not working.

2. Workplace Practices

All the workplace practices discussed in this unit must be permanently posted near the door of each sterilizer prior to use by any operator.

a. *Changing of supply line filters.* Filters in the sterilizer liquid line must be changed when necessary, by the following procedure:

i. Close the cylinder valve and the hose valve.

ii. Disconnect the cylinder hose (piping) from the cylinder.

iii. Open the hose valve and bleed slowly into a proper ventilating system at or near the in-use supply cylinders.

iv. Vacate the area until the line is empty.

v. Change the filter.

vi. Reconnect the lines and reverse the value position.

vii. Check hoses, filters, and valves for leaks with a fluorocarbon leak detector (for those sterilizers using the 88 percent chlorofluorocarbon, 12 percent ethylene oxide mixture (12/88)).

b. *Restricted access area.* i. Areas involving use of EtO must be designated as restricted access areas. They must be identified with signs or floor marks near the sterilizer door, aerator, vacuum pump floor drain discharge, and in-use cylinder storage.

ii. All personnel must be excluded from the restricted area when certain operations are in progress, such as discharging a vacuum pump, emptying a sterilizer liquid line, or venting a non-purge sterilizer with the door ajar or other operations where EtO might be released directly into the face of workers.

c. *Door opening procedures.* i. *Sterilizers with purge cycles.* A load treated in a sterilizer equipped with a purge cycle should be removed immediately upon completion of the cycle (provided no time is lost opening the door after cycle is completed). If this is not done, the purge cycle should be repeated before opening door.

ii. *Sterilizers without purge cycles.* For a load treated in a sterilizer not equipped with a purge cycle, the sterilizer door must be ajar 6" for 15 minutes, and then fully opened for at least another 15 minutes before removing the treated load. The length of time of the second period should be established by peak monitoring for one hour after the two 15-minute periods suggested. If the level is above 10 ppm time-weighted average for 8 hours, more time should be added to the second waiting period (door wide open). However, in no case may the second period be shortened to less than 15 minutes.

d. *Chamber unloading procedures.* i. Procedures for unloading the chamber must include the use of baskets or rolling carts, or baskets and rolling tables to transfer treated loads quickly, thus avoiding excessive contact with treated articles, and reducing the duration of exposures.

ii. If rolling carts are used, they should be pulled not pushed by the sterilizer operators to avoid offgassing exposure.

e. *Maintenance.* A written log should be instituted and maintained documenting the date of each leak detection and any maintenance procedures undertaken. This is a suggested use practice and is not required.

i. *Leak detection.* Sterilizer door gaskets, cylinder and vacuum piping, hoses, filters, and valves must be checked for leaks under full pressure with a Fluorocarbon leak detector (for 12/88 systems only) every two weeks by maintenance personnel. Also, the cylinder piping connections must be checked after changing cylinders. Particular attention in leak detection should be given

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to the automatic solenoid valves that control the flow of EtO to the sterilizer. Specifically, a check should be made at the EtO gasline entrance port to the sterilizer, while the sterilizer door is open and the solenoid valves are in a closed position.

ii. *Maintenance procedures.* Sterilizer/areator door gaskets, valves, and fittings must be replaced when necessary as determined by maintenance personnel in their biweekly checks; in addition, visual inspection of the door gaskets for cracks, debris, and other foreign substances should be conducted daily by the operator.

Appendix B—Substance Technical Guidelines for Ethylene Oxide

I. Physical and Chemical Data

A. Substance identification:

1. Synonyms: dihydrooxirene, dimethylene oxide, EO, 1,2-epoxyethane, EtO ETO oxacyclopropane, oxane, oxidoethane, alpha/beta-oxidoethane, oxiran, oxirane.

2. Formula: (C_2H_4O).

3. Molecular weight: 44.06

B. Physical data:

1. Boiling point (760 mm Hg): 10.70°C (51.3°F);

2. Specific gravity (water = 1): 0.87 (at 20°C or 68°F)

3. Vapor density (air = 1): 1.49;

4. Vapor pressure (at 20°C): 1,095 mm Hg;

5. Solubility in water: complete;

6. Appearance and odor: colorless liquid; gas at temperature above 10.7°F or 51.3°C with ether-like odor above 700 ppm.

II. Fire, Explosion, and Reactivity Hazard Data

A. Fire:

1. Flash point: less than O°F (open cup);

2. Stability: decomposes violently at temperatures above 800°F;

3. Flammable limits in air, percent by volume: Lower: 3, Upper: 100;

4. Extinguishing media: Carbon dioxide for small fires, polymer or alcohol foams for large fires;

5. Special fire fighting procedures: Dilution of ethylene oxide with 23 volumes of water renders it non-flammable;

6. Unusual fire and explosion hazards: Vapors of EtO will burn without the presence of air or other oxidizers. EtO vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which EtO is being used.

7. For purposes of compliance with the requirements of 29 CFR 1910.106, EtO is classified as a flammable gas. For example, 7,500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.

8. For purposes of compliance with 29 CFR 1910.155, EtO is classified as a Class B fire hazard.

9. For purpose of compliance with 29 CFR 1919.307, locations classified as hazardous due to the presence of EtO shall be Class I.

B. Reactivity:

1. Conditions contributing to instability: EtO will polymerize violently if contaminated with aqueous alkalies, amines, mineral acids, metal chlorides, or metal oxides. Violent decomposition will also occur at temperatures above 800 °F;

2. Incompatabilities: Alkalines and acids;

3. Hazardous decomposition products: Carbon monoxide and carbon dioxide.

III. Spill, Leak, and Disposal Procedures

A. If EtO is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.

2. The area should be evacuated at once and re-entered only after the area has been thoroughly ventilated and washed down with water.

B. Persons not wearing appropriate protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. In selecting the method of waste disposal, applicable local, State, and Federal regulations should be consulted.

IV. Monitoring and Measurement Procedures

A. Exposure above the Permissible Exposure Limit:

1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken with consecutive samples covering the full shift. Air samples must be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. Monitoring techniques: The sampling and analysis under this section may be performed by collection of the EtO vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as real-time continuous monitoring systems, portable direct reading instruments, or passive dosimeters as long as measurements taken using these methods accurately evaluate the concentration of EtO in employees' breathing zones.

Appendix D describes the validated method of sampling and analysis which has been tested by OSHA for use with EtO. Other available methods are also described

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in Appendix D. The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that the method of monitoring must be accurate, to a 95 percent confidence level, to plus or minus 25 percent for concentrations of EtO at 1 ppm, and to plus or minus 35 percent for concentrations at 0.5 ppm. In addition to the method described in Appendix D, there are numerous other methods available for monitoring for EtO in the workplace. Details on these other methods have been submitted by various companies to the rulemaking record, and are available at the OSHA Docket Office.

B. Since many of the duties relating to employee exposure are dependent on the results of measurement procedures, employers must assure that the evaluation of employee exposures is performed by a technically qualified person.

V. Protective Clothing and Equipment

Employees shall be provided with and be required to wear appropriate protective clothing wherever there is significant potential for skin contact with liquid EtO or EtO-containing solutions. Protective clothing shall include impermeable coveralls or similar full-body work clothing, gloves, and head coverings, as appropriate to protect areas of the body which may come in contact with liquid EtO or EtO-containing solutions.

Employers must ascertain that the protective garments are impermeable to EtO. Permeable clothing, including items made of rubber, and leather shoes should not be allowed to become contaminated with liquid EtO. If permeable clothing does become contaminated, it should be immediately removed, while the employer is under an emergency deluge shower. If leather footwear or other leather garments become wet from EtO they should be discarded and not be worn again, because leather absorbs EtO and holds it against the skin.

Any protective clothing that has been damaged or is otherwise found to be defective should be repaired or replaced. Clean protective clothing should be provided to the employee as necessary to assure employee protection. Whenever impermeable clothing becomes wet with liquid EtO, it should be washed down with water before being removed by the employee. Employees are also required to wear splash-proof safety goggles where there is any possibility of EtO contacting the eyes.

VI. Miscellaneous Precautions

A. Store EtO in tightly closed containers in a cool, well-ventilated area and take all necessary precautions to avoid any explosion hazard.

B. Non-sparking tools must be used to open and close metal containers. These containers must be effectively grounded and bonded.

C. Do not incinerate EtO cartridges, tanks or other containers.

D. Employers shall advise employees of all areas and operations where exposure to EtO occur.

VII. Common Operations

Common operations in which exposure to EtO is likely to occur include the following: Manufacture of EtO, surfactants, ethanolamines, glycol ethers, and specialty chemicals, and use as a sterilant in the hospital, health product and spice industries.

Appendix C-Medical Surveillance Guidelines for Ethylene Oxide

I. Route of Entry

Inhalation.

II. Toxicology

Clinical evidence of adverse effects associated with the exposure to EtO is present in the form of increased incidence of cancer in laboratory animals (leukemia, stomach, brain), mutation in offspring in animals, and resorptions and spontaneous abortions in animals and human populations respectively. Findings in humans and experimental animals exposed to airborne concentrations of EtO also indicate damage to the genetic material (DNA). These include hemoglobin alkylation, unsecheduled DNA synthesis, sister chromatid exchange chromosomal aberration, and functional sperm abnormalities.

Ethylene oxide in liquid form can cause eye irritation and injury to the cornea, frostbite, severe irritation, and blistering of the skin upon prolonged or confined contact. Ingestion of EtO can cause gastric irritation and liver injury. Other effects from inhalation of EtO vapors include respiratory irritation and lung injury, headache, nausea, vomiting, diarrhea, dyspnea and cyanosis.

III. Signs and Symptoms of Acute Overexposure

The early effects of acute overexposure to EtO are nausea and vomiting, headache, and irritation of the eyes and respiratory passages. The patient may notice a "peculiar taste" in the mouth. Delayed effects can include pulmonary edema, drowsiness, weakness, and incoordination. Studies suggest that blood cell changes, an increase in chromosomal aberrations, and spontaneous abortion may also be causally related to acute overexposure to EtO.

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Skin contact with liquid or gaseous EtO causes characteristic burns and possibly even an allergic-type sensitization. The edema and erythema occurring from skin contact with EtO progress to vesiculation with a tendency to coalesce into blebs with desquamation. Healing occurs within three weeks, but there may be a residual brown pigmentation. A 40-80% solution is extremely dangerous, causing extensive blistering after only brief contact. Pure liquid EtO causes frostbite because of rapid evaporation. In contrast, the eye is relatively insensitive to EtO, but there may be some irritation of the cornea.

Most reported acute effects of occupational exposure to EtO are due to contact with EtO in liquid phase. The liquid readily penetrates rubber and leather, and will produce blistering if clothing or footwear contaminated with EtO are not removed.

IV. Surveillance and Preventive Considerations

As noted above, exposure to EtO has been linked to an increased risk of cancer and reproductive effects including decreased male fertility, fetotoxicity, and spontaneous abortion. EtO workers are more likely to have chromosomal damage than similar groups not exposed to EtO. At the present, limited studies of chronic effects in humans resulting from exposure to EtO suggest a causal association with leukemia. Animal studies indicate leukemia and cancers at other sites (brain, stomach) as well. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to EtO.

Adequate screening tests to determine an employee's potential for developing serious chronic diseases, such as cancer, from exposure to EtO do not presently exist. Laboratory tests may, however, give evidence to suggest that an employee is potentially overexposed to EtO. It is important for the physician to become familiar with the operating conditions in which exposure to EtO is likely to occur. The physician also must become familiar with the signs and symptoms that indicate a worker is receiving otherwise unrecognized and unacceptable exposure to EtO. These elements are especially important in evaluating the medical and work histories and in conducting the physical exam. When an unacceptable exposure in an active employee is identified by the physician, measures taken by the employer to lower 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 EtO at or above the action level (0.5 ppm) for at least 30 days per year, without regard to respirator use. All examinations and procedures must be performed by or under the supervision of a licensed physician at a reasonable time and place for the employee and at no cost to the employee.

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

(i) Medical and work histories with special emphasis directed to symptoms related to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(ii) Physical examination with particular emphasis given to the pulmonary, hematologic, neurologic, and reproductive systems and to the eyes and skin.

(iii) Complete blood count to include at least a white cell count (including differential cell count), red cell count, hematocrit, and hemoglobin.

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

If requested by the employee, the medical examinations shall include pregnancy testing or laboratory evaluation of fertility as deemed appropriate by the physician.

In certain cases, to provide sound medical advice to the employer and the employee, the physician must evaluate situations not directly related to EtO. For example, employees with skin diseases may be unable to tolerate wearing protective clothing. In addition those with chronic respiratory diseases may not tolerate the wearing of negative pressure (air purifying) respirators. Additional tests and procedures that will help the physician determine which employees are medically unable to wear such respirators should include: An evaluation of cardiovascular function, a baseline chest x-ray to be repeated at five year intervals, and a pulmonary function test to be repeated every three years. The pulmonary function test should include measurement of the employee's forced vital capacity (FVC), forced expiratory volume at one second (FEV1), as well as calculation of the ratios of FEV1 to FVC, and measured FVC and measured FEV1 to expected values corrected for variation due to age, sex, race, and height.

The employer is required to make the prescribed tests available at least annually to employees who are or will be exposed at or above the action level, for 30 or more days per year; more often than specified if recommended by the examining physician; and upon the employee's termination of employment or reassignment to another work area. While little is known about the long term consequences of high short-term exposures, it appears prudent to monitor such affected employees closely in light of existing health

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data. The employer shall provide physician recommended examinations to any employee exposed to EtO in emergency conditions. Likewise, the employer shall make available medical consultations including physician recommended exams to employees who believe they are suffering signs or symptoms of exposure to EtO.

The employer is required to provide the physician with the following informatin: a copy of this standard and its appendices; a description of the affected employee's duties as they relate to the employee exposure level; and information from the employee's previous medical examinations which is not readily available to the examining 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, when required.

The employer is required to obtain a written opinion from the examining physician containing the results of the medical examinations, the physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of his or her health from exposure to EtO; any recommended restrictions upon the employee's exposure to EtO, or upon the use of protective clothing or equipment such as respirators; and a statement that the employee has been informed by the physician of the results of the medical examination and of any medical conditions which require further explanation or treatment. This written opinion must not reveal specific findings or diagnoses unrelated to occupational exposure to EtO, and a copy of the opinion must be provided to the affected employee.

The purpose in requiring the examining physician to supply the employer with a written opinion is to provide the employer with a medical basis to aid in the determination of initial placement of employees and to assess the employee's ability to use protective clothing and equipment.

Appendix D—Sampling and Analytical Methods for Ethylene Oxide

A number of methods are available for monitoring employee exposures to EtO. Most of these involve the use of charcoal tubes and sampling pumps, followed by analysis of the samples by gas chromatograph. The essential differences between the charcoal tube methods include, among others, the use of different desorbing solvents, the use of different lots of charcoal, and the use of different equipment for analysis of the samples.

Besides charcoal, methods using passive dosimeters, gas sampling bags, impingers, and detector tubes have been utilized for determination of EtO exposure. In addition, there are several commercially available portable gas analyzers and monitoring units.

This appendix contains details for the method which has been tested at the OSHA Analytical Laboratory in Salt Lake City. Inclusion of this method in the appendix does not mean that this method is the only one which will be satisfactory. Copies of descriptions of other methods available are available in the rulemaking record, and may be obtained from the OSHA Docket Office. These include the Union Carbide, Dow Chemical, 3M, and DuPont methods, as well as NIOSH Method S-286. These methods are briefly described at the end of this appendix.

Employers who note problems with sample breakthrough using the OSHA or other charcoal methods should try larger charcoal tubes. Tubes of larger capacity are available. In addition, lower flow rates and shorter sampling times should be beneficial in minimizing breakthrough problems. Whatever method the employer chooses, he must assure himself of the method's accuracy and precision under the unique conditions present in his workplace.

Ethylene Oxide

Method No.: 30.

Matrix: Air.

Target Concentration: 1.0 ppm (1.8 mg/m^3).

Procedure: Samples are collected on two charcoal tubes in series and desorbed with 1% CS_2 in benzene. The samples are derivatized with HBr and treated with sodium carbonate. Analysis is done by gas chromatography with an electron capture detector.

Recommended Air Volume and Sampling Rate: 1 liter and 0.05 Lpm.

Detection Limit of the Overall Procedure: 13.3 ppb (0.024 mg/m^3) (Based on 1.0 liter air sample).

Reliable Quantitation Limit: 52.2 ppb (0.094 mg/m^3) (Based on 1.0 liter air sample).

Standard Error of Estimate: 6.59% (See Backup Section 4.6).

Special Requirements: Samples must be analyzed within 15 days of sampling date.

Status of Method: The sampling and analytical method has been subjected to the established evaluation procedures of the Organic Method Evaluations Branch.

Date: August 1981.

Chemist: Wayne D. Potter.

Organic Solvents Branch, OSHA Analytical Laboratory, Salt Lake City, Utah

1. General Discussion.

1.1 Background.

1.1.1 History of Procedure.

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Ethylene oxide samples analyzed at the OSHA Laboratory have normally been collected on activated charcoal and desorbed with carbon disulfide. The analysis is performed with a gas chromatograph equipped with a FID (Flame ionization detector) as described in NIOSH Method S286 (Ref. 5.1). This method is based on a PEL of 50 ppm and has a detection limit of about 1 ppm.

Recent studies have prompted the need for a method to analyze and detect ethylene oxide at very low concentrations.

Several attempts were made to form an ultraviolet (UV) sensitive derivative with ethylene oxide for analysis with HPLC. Among those tested that gave no detectable product were: p-anisidine, methylimidazole, aniline, and 2,3,6-trichlorobenzoic acid. Each was tested with catalysts such as triethylamine, aluminum chloride, methylene chloride and sulfuric acid but no detectable derivative was produced.

The next derivatization attempt was to react ethylene oxide with HBr to form 2-bromoethanol. This reaction was successful. An ECD (electron capture detector) gave a very good response for 2-bromoethanol due to the presence of bromine. The use of carbon disulfide as the desorbing solvent gave too large a response and masked the 2-bromoethanol. Several other solvents were tested for both their response on the ECD and their ability to desorb ethylene oxide from the charcoal. Among those tested were toluene, xylene, ethyl benzene, hexane, cyclohexane and benzene. Benzene was the only solvent tested that gave a suitable response on the ECD and a high desorption. It was found that the desorption efficiency was improved by using 1% CS_2 with the benzene. The carbon disulfide did not significantly improve the recovery with the other solvents. SKC Lot 120 was used in all tests done with activated charcoal.

1.1.2 Physical Properties (Ref. 5.2-5.4).

Synonyms: Oxirane; dimethylene oxide, 1,2-epoxy-ethane; oxane; C_2H_4O; ETO;
Molecular Weight: 44.06
Boiling Point: 10.7 °C (51.3°)
Melting Point: −111 °C
Description: Colorless, flammable gas
Vapor Pressure: 1095 mm. at 20 °C
Odor: Ether-like odor
Lower Explosive Limits: 3.0% (by volume)
Flash Point (TOC): Below 0 °F
Molecular Structure: $CH_2—CH_2$

1.2 Limit Defining Parameters.

1.2.1 Detection Limit of the Analytical Procedure.

The detection limit of the analytical procedure is 12.0 picograms of ethylene oxide per injection. This is the amount of analyte which will give a peak whose height is five times the height of the baseline noise. (See Backup Data Section 4.1).

1.2.2 Detection Limit of the Overall Procedure.

The detection limit of the overall procedure is 24.0 ng of ethylene oxide per sample.

This is the amount of analyte spiked on the sampling device which allows recovery of an amount of analyte equivalent to the detection limit of the analytical procedure. (See Backup Data Section 4.2).

1.2.3 Reliable Quantitation Limit.

The reliable quantitation limit is 94.0 nanograms of ethylene oxide per sample. This is the smallest amount of analyte which can be quantitated within the requirements of 75% recovery and 95% confidence limits. (See Backup Data Section 4.2).

It must be recognized that the reliable quantitation limit and detection limits reported in the method are based upon optimization of the instrument for the smallest possible amount of analyte. When the target concentration of an analyte is exceptionally higher than these limits, they may not be attainable at the routine operating parameters. In this case, the limits reported on analysis reports will be based on the operating parameters used during the analysis of the samples.

1.2.4 Sensitivity.

The sensitivity of the analytical procedure over a concentration range representing 0.5 to 2 times the target concentration based on the recommended air volume is 34105 area units per μg/mL. The sensitivity is determined by the slope of the calibration curve (See Backup Data Section 4.3).

The sensitivity will vary somewhat with the particular instrument used in the analysis.

1.2.5 Recovery.

The recovery of analyte from the collection medium must be 75% or greater. The average recovery from spiked samples over the range of 0.5 to 2 times the target concentration is 88.0% (See Backup Section 4.4). At lower concentrations the recovery appears to be non-linear.

1.2.6 Precision (Analytical Method Only).

The pooled coefficient of variation obtained from replicate determination of analytical standards at 0.5X, 1X and 2X the target concentration is 0.036 (See Backup Data Section 4.5).

1.2.7 Precision (Overall Procedure).

The overall procedure must provide results at the target concentration that are 25% of better at the 95% confidence level. The precision at the 95% confidence level for the 15 day storage test is plus or minus 12.9% (See Backup Data Section 4.6).

This includes an additional plus or minus 5% for sampling error.

1.3 Advantages.

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1.3.1 The sampling procedure is convenient.

1.3.2 The analytical procedure is very sensitive and reproducible.

1.3.3 Reanalysis of samples is possible.

1.3.4 Samples are stable for at least 15 days at room temperature.

1.3.5 Interferences are reduced by the longer GC retention time of the new derivative.

1.4 Disadvantages.

1.4.1 Two tubes in series must be used because of possible breakthrough and migration.

1.4.2 The precision of the sampling rate may be limited by the reproducibility of the pressure drop across the tubes. The pumps are usually calibrated for one tube only.

1.4.3 The use of benzene as the desorption solvent increases the hazards of analysis because of the potential carcinogenic effects of benzene.

1.4.4 After repeated injections there can be a buildup of residue formed on the electron capture detector which decreases sensitivity.

1.4.5 Recovery from the charcoal tubes appears to be nonlinear at low concentrations.

2. Sampling Procedure.

2.1 Apparatus.

2.1.1 A calibrated personal sampling pump whose flow can be determined within plus or minus 5% of the recommended flow.

2.1.2 SKC Lot 120 Charcoal tubes: glass tube with both ends flame sealed, 7 cm long with a 6 mm O.D. and a 4-mm I.D., containing 2 sections of coconut shell charcoal separated by a 2-mm portion of urethane foam. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silylated glass wool is placed in front of the adsorbing section.

2.2 Reagents.

2.2.1 None required.

2.3 Sampling Technique.

2.3.1 Immediately before sampling, break the ends of the charcoal tubes. All tubes must be from the same lot.

2.3.2 Connect two tubes in series to the sampling pump with a short section of flexible tubing. A minimum amount of tubing is used to connect the two sampling tubes together. The tube closer to the pump is used as a backup. This tube should be identified as the backup tube.

2.3.3 The tubes should be placed in a vertical position during sampling to minimize channeling.

2.3.4 Air being sampled should not pass through any hose or tubing before entering the charcoal tubes.

2.3.5 Seal the charcoal tubes with plastic caps immediately after sampling. Also, seal each sample with OSHA seals lengthwise.

2.3.6 With each batch of samples, submit at least one blank tube from the same lot used for samples. This tube should be subjected to exactly the same handling as the samples (break, seal, transport) except that no air is drawn through it.

2.3.7 Transport the samples (and corresponding paperwork) to the lab for analysis.

2.3.8 If bulk samples are submitted for analysis, they shoud be transported in glass containers with Teflon-lined caps. These samples must be mailed separately from the container used for the charcoal tubes.

2.4 Breakthrough.

2.4.1 The breakthrough (5% breakthrough) volume for a 3.0 mg/m ethylene oxide sample stream at approximately 85% relative humidity, 22°C and 633 mm is 2.6 liters sampled at 0.05 liters per minute. This is equivalent to 7.8 μg of ethylene oxide. Upon saturation of the tube it appeared that the water may be displacing ethylene oxide during sampling.

2.5 Desorption Efficiency.

2.5.1 The desorption efficiency, from liquid injection onto charcoal tubes, averaged 88.0% from 0.5 to 2.0 x the target concentration for a 1.0 liter air sample. At lower ranges it appears that the desorption efficiency is non-linear (See Backup Data Section 4.2).

2.5.2 The desorption efficiency may vary from one laboratory to another and also from one lot of charcoal to another. Thus, it is necessary to determine the desorption efficiency for a particular lot of charcoal.

2.6 Recommended Air Volume and Sampling Rate.

2.6.1 The recommended air volume is 1.0 liter.

2.6.2 The recommended maximum sampling rate is 0.05 Lpm.

2.7 Interferences.

2.7.1 Ethylene glycol and Freon 12 at target concentration levels did not interfere with the collection of ethylene oxide.

2.7.2 Suspected interferences should be listed on the sample data sheets.

2.7.3 The relative humidity may affect the sampling procedure.

2.8 Safety Precautions.

2.8.1 Attach the sampling equipment to the employee so that it does not interfere with work performance.

2.8.2 Wear safety glasses when breaking the ends of the sampling tubes.

2.8.3 If possible, place the sampling tubes in a holder so the sharp end is not exposed while sampling.

3. Analytical Method.

3.1 Apparatus.

3.1.1 Gas chromatograph equipped with a linearized electron capture detector.

3.1.2 GC column capable of separating the derivative of ethylene oxide (2-bromoethanol) from any interferences and the

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1% CS_2 in benzene solvent. The column used for validation studies was: 10 ft x ¼ inch stainless steel 20% SP-2100, .1% Carbowax 1500 on 100/120 Supelcoport.

3.1.3 An electronic integrator or some other suitable method of measuring peak areas.

3.1.4 Two milliliter vials with Teflon-lined caps.

3.1.5 Gas tight syringe—500 μL or other convenient sizes for preparing standards.

3.1.6 Microliter syringes—10 μL or other convenient sizes for diluting standards and 1 μL for sample injections.

3.1.7 Pipets for dispensing the 1% CS_2 in benzene solvent. The Glenco 1 mL dispenser is adequate and convenient.

3.1.8 Volumetric flasks—5 mL and other convenient sizes for preparing standards.

3.1.9 Disposable Pasteur pipets.

3.2 Reagents.

3.2.1 Benzene, reagent grade.

3.2.2 Carbon Disulfide, reagent grade.

3.2.3 Ethylene oxide, 99.7% pure.

3.2.4 Hydrobromic Acid, 48% reagent grade.

3.2.5 Sodium Carbonate, anhydrous, reagent grade.

3.2.6 Desorbing reagent, 99% Benzene/1% CS_2.

3.3 Sample Preparation.

3.3.1 The front and back sections of each sample are transferred to separate 2-mL vials.

3.3.2 Each sample is desorbed with 1.0 mL of desorbing reagent.

3.3.3 The vials are sealed immediately and allowed to desorb for one hour with occasional shaking.

3.3.4 Desorbing reagent is drawn off the charcoal with a disposable pipet and put into clean 2-mL vials.

3.3.5 One drop of HBr is added to each vial. Vials are resealed and HBr is mixed well with the desorbing reagent.

3.3.6 About 0.15 gram of sodium carbonate is carefully added to each vial. Vials are again resealed and mixed well.

3.4 Standard Preparation.

3.4.1 Standards are prepared by injecting the pure ethylene oxide gas into the desorbing reagent.

3.4.2 A range of standards are prepared to make a calibration curve. A concentration of 1.0 μL of ethylene oxide gas per 1 mL desorbing reagent is equivalent to 1.0 ppm air concentration (all gas volumes at 25°C and 760 mm) for the recommended 1 liter air sample. This amount is uncorrected for desorption efficiency (See Backup Data Section 4.2. for desorption efficiency corrections).

3.4.3 One drop of HBr per mL of standard is added and mixed well.

3.4.4 About 0.15 grams of sodium carbonate is carefully added for each drop of HBr (A small reaction will occur).

3.5 Analysis.

3.5.1 GC Conditions.

Nitrogen flow rate—10mL/min.
Injector Temperature—250°C
Detector Temperature—300°C
Column Temperature—100°C
Injection size 0.8 μL
Elution time—3.9 minutes

3.5.2 Peak areas are measured by an integrator or other suitable means.

3.5.3 The integrator results are in area units and a calibration curve is set up with concentration vs. area units.

3.6 Interferences.

3.6.1 Any compound having the same retention time of 2-bromoethanol is a potential interference. Possible interferences should be listed on the sample data sheets.

3.6.2 GC parameters may be changed to circumvent interferences.

3.6.3 There are usually trace contaminants in benzene. These contaminants, however, posed no problem of interference.

3.6.4 Retention time data on a single column is not considered proof of chemical identity. Samples over the 1.0 ppm target level should be confirmed by GC/Mass Spec or other suitable means.

3.7 Calculations

3.7.1 The concentration in μg/mL for a sample is determined by comparing the area of a particular sample to the calibration curve, which has been prepared from analytical standards.

3.7.2 The amount of analyte in each sample is corrected for desorption efficiency by use of a desorption curve.

3.7.3 Analytical results (A) from the two tubes that compose a particular air sample are added together.

3.7.4 The concentration for a sample is calculated by the following equation:

$$\text{ETO, mg/m}^3 = \frac{AXB}{C}$$

where:
A = μg/mL
B = desorption volume in milliliters
C = air volume in liters.

3.7.5 To convert mg/m^3 to parts per million (ppm) the following relationship is used:

$$\text{ETO, ppm} = \frac{\text{mg/m}^3 \times 24.45}{44.05}$$

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where:
mg/m³ = results from 3.7.4
24.45 = molar volume at 25 °C and 760mm Hg
44.05 = molecular weight of ETO.

3.8 Safety Precautions

3.8.1 Ethylene oxide and benzene are potential carcinogens and care must be exercised when working with these compounds.

3.8.2 All work done with the solvents (preparation of standards, desorption of samples, etc.) should be done in a hood.

3.8.3 Avoid any skin contact with all of the solvents.

3.8.4 Wear safety glasses at all times.

3.8.5 Avoid skin contact with HBr because it is highly toxic and a strong irritant to eyes and skin.

4. Backup Data.

4.1 Detection Limit Data.

The detection limit was determined by injecting 0.8 μL of a 0.015 μg/mL standard of ethylene oxide into 1% CS_2 in benzene. The detection limit of the analytical procedure is taken to be 1.20×10^{-2} μg per injection. This is equivalent to 8.3 ppb (0.015 mg/m³) for the recommended air volume.

4.2 Desorption Efficiency.

Ethylene oxide was spiked onto charcoal tubes and the following recovery data was obtained.

Amount spiked (μg)	Amount recovered (μg)	Percent recovery
4.5	4.32	96.0
3.0	2.61	87.0
2.25	2.025	90.0
1.5	1.365	91.0
1.5	1.38	92.0
.75	.6525	87.0
.375	.315	84.0
.375	.312	83.2
.1875	.151	80.5
.094	.070	74.5

At lower amounts the recovery appears to be non-linear.

4.3 Sensitivity Data.

The following data was used to determine the calibration curve.

Injection	0.5 - .75 μg/mL	1 - 1.5 μg/mL	2 - 3.0 μg/mL
1	30904	59567	111778
2	30987	62914	106016
3	32555	58578	106122
4	32242	57173	109716
X	31672	59558	108408

Slope = 34 105

4.4 Recovery.

The recovery was determined by spiking ethylene oxide onto lot 120 charcoal tubes and desorbing with 1% CS_2 in Benzene. Recoveries were done at 0.5, 1.0, and 2.0 X the target concentration (1 ppm) for the recommended air volume.

PERCENT RECOVERY

Sample	0.5x	1.0x	2.0x
1	88.7	95.0	91.7
2	83.8	95.0	87.3
3	84.2	91.0	86.0
4	88.0	91.0	83.0
5	88.0	86.0	85.0
X	86.5	90.5	87.0

Weighted Average = 88.2

4.5 Precision of the Analytical Procedure

The following data was used to determine the precision of the analytical method:

Concentration	0.5x.75 μg/mL	1X1.5 μg/mL	2X3.0 μg/mL
Injection	.7421	1.4899	3.1184
	.7441	1.5826	3.0447
	.7831	1.4628	2.9149
	.7753	1.4244	2.9185
Average	.7612	1.4899	2.9991
Standard Deviation	.0211	.0674	.0998
CV	.0277	.0452	.0333

$$CV = \frac{3(.0277)^2 + 3(.0452)^2 + 3(.0333)^2}{3 + 3 + 3}$$

CV = 0.036

4.6 Storage Data.

Samples were generated at 1.5 mg/m³ ethylene oxide at 85% relative humidity, 22°C and 633 mm. All samples were taken for 20 minutes at 0.05 Lpm. Six samples were analyzed as soon as possible and fifteen samples were stored at refrigerated temperature (5°C) and fifteen samples were stored at ambient temperature (23°C). These stored samples were analyzed over a period of nineteen days.

PERCENT RECOVERY

Day analyzed	Refrigerated	Ambient
1	87.0	87.0
1	93.0	93.0
1	94.0	94.0

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PERCENT RECOVERY—Continued

Day analyzed	Refrigerated	Ambient
1	92.0	92.0
4	92.0	91.0
4	93.0	88.0
4	91.0	89.0
6	92.0	
6	92.0	
8		92.0
8		86.0
10	91.7	
10	95.5	
10	95.7	
11		90.0
11		82.0
13	78.0	
13	81.4	
13	82.4	
14		78.5
14		72.1
18	66.0	
18	68.0	
19		64.0
19		77.0

4.7 Breakthrough Data.

Breakthrough studies were done at 2 ppm (3.6 mg/m³) at approximately 85% relative humidity at 22°C (ambient temperature). Two charcoal tubes were used in series. The backup tube was changed every 10 minutes and analyzed for breakthrough. The flow rate was 0.050 Lpm.

Tube No.	Time (minutes)	Percent breakthrough
1	10	(1)
2	20	(1)
3	30	(1)
4	40	1.23
5	50	3.46
6	60	18.71
7	70	39.2
8	80	53.3
9	90	72.0
10	100	96.0
11	110	113.0
12	120	133.9

[1] None.

The 5% breakthrough volume was reached when 2.6 liters of test atmosphere were drawn through the charcoal tubes.

5. References.

5.1 "NIOSH Manual of Analytical Methods," 2nd ed. NIOSH: Cincinnati, 1977; Method S286.

5.2 "IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man," International Agency for Research on Cancer: Lyon, 1976; Vol. 11, p. 157.

5.3 Sax., N.I. "Dangerous Properties of Industrial Materials," 4th ed.; Van Nostrand Reinhold Company. New York, 1975; p. 741.

5.4 "The Condensed Chemical Dictionary", 9th ed.; Hawley, G.G., ed.; Van Nostrand Reinhold Company. New York, 1977; p. 361.

Summary of Other Sampling Procedures

OSHA believes that served other types of monitoring equipment and techniques exist for monitoring time-weighted averages. Considerable research and method development is currently being performed, which will lead to improvements and a wider variety of monitoring techniques. A combination of monitoring procedures can be used. There probably is no one best method for monitoring personal exposure to ethylene oxide in all cases. There are advantages, disadvantages, and limitations to each method. The method of choice will depend on the need and requirements. Some commonly used methods include the use of charcoal tubes, passive dosimeters, Tedler gas sampling bags, detector tubes, photoionization detection units, infrared detection units and gas chromatographs. A number of these methods are described below.

A. Charcoal Tube Sampling Procedures

Qazi-Ketcham method (Ex. 11-133)—This method consists of collecting EtO on Columbia JXC activated carbon, desorbing the EtO with carbon disulfide and analyzing by gas chromatography with flame ionization detection. Union Carbide has recently updated and revalidated this monitoring procedures. This method is capable of determining both eight-hour time-weighted average exposures and short-term exposures. The method was validated to 0.5 ppm. Like other charcoal collecting procedures, the method requires considerable analytical expertise.

ASTM-proposed method—The Ethylene Oxide Industry Council (EOIC) has contracted with Clayton Environmental Consultants, Inc. to conduct a collaborative study for the proposed method. The ASTM-Proposed method is similar to the method published by Qazi and Ketcham is the November 1977 American Industrial Hygiene Association Journal, and to the method of Pilney and Coyne, presented at the 1979 American Industrial Hygiene Conference. After the air to be sampled is drawn through an activated charcoal tube, the ethylene oxide is desorbed from the tube using carbon disulfide and is quantitated by gas chromatography utilizing a flame ionization detector. The ASTM-proposed method specifies a large two-section charcoal tube, shipment in dry ice, storage at less than −5°C, and analysis within three weeks to prevent migration and sample loss. Two types of charcoal tubes are being tested—

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Pittsburgh Coconut-Based (PCB) and Columbia JXC charcoal. This collaborative study will give an indication of the inter- and intralaboratory precision and accuracy of the ASTM-proposed method. Several laboratories have considerable expertise using the Qazi-Ketcham and Dow methods.

B. Passive Monitors--Ethylene oxide diffuses into the monitor and is collected in the sampling media. The DuPont Pro-Tek badge collects EtO in an absorbing solution, which is analyzed colorimetrically to determine the amount of EtO present. The 3M 350 badge collects the EtO on chemically treated charcoal. Other passive monitors are currently being developed and tested. Both 3M and DuPont have submitted data indicating their dosimeters meet the precision and accuracy requirements of the proposed ethylene oxide standard. Both presented laboratory validation data to 0.2 ppm (Exs. 11-65, 4-20, 108, 109, 130).

C. Tedlar Gas Sampling Bags-Samples are collected by drawing a known volume of air into a Tedlar gas sampling bag. The ethylene oxide concentration is often determined on-site using a portable gas chromatograph or portable infrared spectometer.

D. Detector tubes—A known volume of air is drawn through a detector tube using a small hand pump. The concentration of EtO is related to the length of stain developed in the tube. Detector tubes are economical, easy to use, and give an immediate readout. Unfortunately, partly because they are nonspecific, their accuracy is often questionable. Since the sample is taken over a short period of time, they may be useful for determining the source of leaks.

E. Direct Reading Instruments—There are numerous types of direct reading instruments, each having its own strengths and weaknesses (Exs. 135B, 135C, 107, 11-78, 11-153). Many are relatively new, offering greater sensitivity and specificity. Popular ethylene oxide direct reading instruments include infrared detection units, photoionization detection units, and gas chromatographs.

Portable infrared analyzers provide an immediate, continuous indication of a concentration value; making them particularly useful for locating high concentration pockets, in leak detection and in ambient air monitoring. In infrared detection units, the amount of infrared light absorbed by the gas being analyzed at selected infrared wavelengths is related to the concentration of a particular component. Various models have either fixed or variable infrared filters, differing cell pathlengths, and microcomputer controls for greater sensitivity, automation, and interference elimination.

A fairly recent detection system is photoionization detection. The molecules are ionized by high energy ultraviolet light. The resulting current is measured. Since different substances have different ionization potentials, other organic compounds may be ionized. The lower the lamp energy, the better the selectivity. As a continuous monitor, photoionization detection can be useful for locating high concentration pockets, in leak detection, and continuous ambient air monitoring. Both portable and stationary gas chromatographs are available with various types of detectors, including photoionization detectors. A gas chromatograph with a photoionization detector retains the photionization sensitivity, but minimizes or eliminates interferences. For several GC/PID units, the sensitivity is in the 0.1-0.2 ppm EtO range. The GC/PID with microprocessors can sample up to 20 sample points sequentially, calculate and record data, and activate alarms or ventilation systems. Many are quite flexible and can be configured to meet the specific analysis needs for the workplace.

DuPont presented their laboratory validation data of the accuracy of the Qazi-Ketcham charcoal tube, the PCB charcoal tube, Miran 103 IR analyzer, 3M #3550 monitor and the Du Pont C-70 badge. Quoting Elbert V. Kring:

We also beleive that OSHA's proposed accuracy in this standard is appropriate. At plus or minus 25 percent at one part per million, and plus or minus 35 percent below that. And, our data indicates there's only one monitoring method, right now, that we've tested thoroughly, that meets that accuracy requirements. That is the Du Pont Pro-Tek badge* * *. We also believe that this kind of data should be confirmed by another independent laboratory, using the same type dynamic chamber testing (Tr. 1470)

Additional data by an independent laboratory following their exact protocol was not submitted. However, information was submitted on comparisons and precision and accuracy of those monitoring procedures which indicate far better precision and accuracy of those monitoring procedures than that obtained by Du Pont (Ex. 4-20, 130, 11-68, 11-133, 130, 135A).

The accuracy of any method depends to a large degree upon the skills and experience of those who not only collect the samples but also those who analyze the samples. Even for methods that are collaboratively tested, some laboratories are closer to the true values than others. Some laboratories may meet the precision and accuracy requirements of the method; others may consistently far exceed them for the same method.

(Approved by the Office of Management and Budget under control number 1218-0108)

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(Secs. 4, 6, and 8, Occupational Safety and Health Act of 1970, 84 Stat. 1592, 1593, 1597, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 9-83 (48 FR 35736); 29 CFR Part 1911)

[49 FR 25796, June 22, 1984, as amended at 50 FR 9801, Mar. 12, 1985]

§ 1910.1200 Hazard communication.

(a) *Purpose.* (1) The purpose of this section is to ensure that the hazards of all chemicals produced or imported by chemical manufacturers or importers are evaluated, and that information concerning their hazards is transmitted to affected employers and employees within the manufacturing sector. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

(2) This occupational safety and health standard is intended to address comprehensively the issue of evaluating and communicating chemical hazards to employees in the manufacturing sector, and to preempt any state law pertaining to this subject. Any state which desires to assume responsibility in this area may only do so under the provisions of section 18 of the Occupational Safety and Health Act (29 U.S.C. 651 et. seq.) which deals with state jurisdiction and state plans.

(b) *Scope and application.* (1) This section requires chemical manufacturers or importers to assess the hazards of chemicals which they produce or import, and all employers in SIC Codes 20 through 39 (Division D, Standard Industrial Classification Manual) to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers in SIC Codes 20-39.

(2) This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

(3) This section applies to laboratories only as follows:

(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees; and,

(iii) Employers shall ensure that laboratory employees are apprised of the hazards of the chemicals in their workplaces in accordance with paragraph (h) of this section.

(4) This section does not require labeling of the following chemicals:

(i) Any pesticide as such term is defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et seq.), when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Environmental Protection Agency;

(ii) Any food, food additive, color additive, drug, or cosmetic, including materials intended for use as ingredients in such products (e.g., flavors and fragrances), as such terms are defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.) and regulations issued under that Act, when they are subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Food and Drug Administration;

(iii) Any distilled spirits (beverage alcohols), wine, or malt beverage intended for nonindustrial use, as such terms are defined in the Federal Alcohol Administration Act (27 U.S.C. 201 et seq.) and regulations issued under that Act, when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Bureau of Alcohol, Tobacco, and Firearms; and,

(iv) Any consumer product or hazardous substance as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 et seq.) and Federal Hazardous Substances Act (15 U.S.C. 1261 et seq.) respectively, when subject to a consumer product safety

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1910.95

OCCUPATIONAL NOISE EXPOSURE

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than welding, burning, and soldering operations, involving the use, melting, smelting, or pouring of metals, alloys, salts, or other similar substances in the molten state. Such operations also include heat treating baths, descaling baths, die casting stereotyping, galvanizing, tinning, and similar operations.

(iii) "Surface coating operations" means all operations involving the application of protective, decorative, adhesive, or strengthening coating or impregnation to one or more surfaces, or into the interstices of any object or material, by means of spraying, spreading, flowing, brushing, roll coating, pouring, cementing, or similar means; and any subsequent draining or drying operations, excluding open-tank operations.

(Secs. 4(b)(2), 6(b) and 8(c), 84 Stat. 1592, 1593, 1596; 29 U.S.C. 653, 655, 657; sec. of Labors Order No. 8-76 (41 FR 25059); 29 CFR 1911; secs. 6, 8, 84 Stat. 1593, 1600 (29 U.S.C. 655, 657), Secretary of Labor's Order No. 9-83 (48 FR 35736), 29 CFR Part 1911)

[39 FR 23502, June 27, 1974, as amended at 40 FR 23073, May 28, 1975; 40 FR 24522, June 9, 1975; 43 FR 49746, Oct. 24, 1978; 49 FR 5322, Feb. 10, 1984]

§ 1910.95 Occupational noise exposure.

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

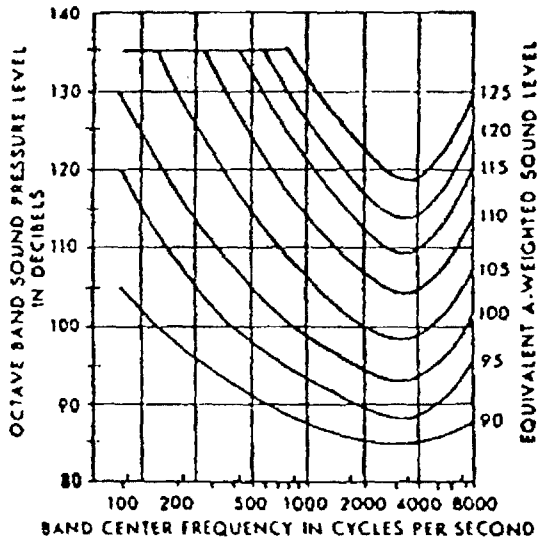


FIGURE G-9

Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 1.G-16.

(b)(1) When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

TABLE G-16—PERMISSIBLE NOISE EXPOSURES [1]

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

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[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 \ldots C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

(c) *Hearing conservation program.* (1) The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with Appendix A and Table G-16a, and without regard to any attenuation provided by the use of personal protective equipment.

(2) For purposes of paragraphs (c) through (n) of this section, an 8-hour time-weighted average of 85 decibels or a dose of fifty percent shall also be referred to as the action level.

(d) *Monitoring.* (1) When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program.

(i) The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors.

(ii) Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this paragraph unless the employer can show that area sampling produces equivalent results.

(2)(i) All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels shall be integrated into the noise measurements.

(ii) Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

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(3) Monitoring shall be repeated whenever a change in production, process, equipment or controls increases noise exposures to the extent that:

(i) Additional employees may be exposed at or above the action level; or

(ii) The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of paragraph (j) of this section.

(e) *Employee notification.* The employer shall notify each employee exposed at or above an 8-hour time-weighted average of 85 decibels of the results of the monitoring.

(f) *Observation of monitoring.* The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section.

(g) *Audiometric testing program.* (1) The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels.

(2) The program shall be provided at no cost to employees.

(3) Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

(4) All audiograms obtained pursuant to this section shall meet the requirements of Appendix C: *Audiometric Measuring Instruments.*

(5) *Baseline audiogram.* (i) Within 6 months of an employee's first exposure at or above the action level, the employer shall establish a valid base-

line audiogram against which subsequent audiograms can be compared.

(ii) *Mobile test van exception.* Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within 1 year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee's first exposure at or above the action level, employees shall wearing hearing protectors for any period exceeding six months after first exposure until the baseline audiogram is obtained.

(iii) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise.

(iv) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(6) *Annual audiogram.* At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

(7) *Evaluation of audiogram.* (i) Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in paragraph (g)(10) of this section has occurred. This comparison may be done by a technician.

(ii) If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

(iii) The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

(A) A copy of the requirements for hearing conservation as set forth in paragraphs (c) through (n) of this section;

(B) The baseline audiogram and most recent audiogram of the employee to be evaluated;

(C) Measurements of background sound pressure levels in the audiometric test room as required in Appendix D: Audiometric Test Rooms.

(D) Records of audiometer calibrations required by paragraph (h)(5) of this section.

(8) *Follow-up procedures.* (i) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

(ii) Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

(A) Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

(B) Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

(C) The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

(D) The employee is informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

(iii) If subsequent audiometric testing of an employee whose exposure to noise is less than an 8-hour TWA of 90 decibels indicates that a standard threshold shift is not persistent, the employer:

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(A) Shall inform the employee of the new audiometric interpretation; and

(B) May discontinue the required use of hearing protectors for that employee.

(9) *Revised baseline.* An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist or physician who is evaluating the audiogram:

(i) The standard threshold shift revealed by the audiogram is persistent; or

(ii) The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

(10) *Standard threshold shift.* (1) As used in this section, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

(ii) In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in Appendix F: *Calculation and Application of Age Correction to Audiograms.*

(h) *Audiometric test requirements.* (1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audiometers, S3.6-1969.

(3) Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix C: *Audiometric Measuring Instruments.*

(4) Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix D: *Audiometric Test Rooms.*

(5) *Audiometer calibration.* (i) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

(ii) Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix E: *Acoustic Calibration of Audiometers.* Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 decibels or greater require an exhaustive calibration.

(iii) An exhaustive calibration shall be performed at least every two years in accordance with sections 4.1.2; 4.1.3.; 4.1.4.3; 4.2; 4.4.1; 4.4.2; 4.4.3; and 4.5 of the American National Standard Specification for Audiometers, S3.6-1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(i) *Hearing protectors.* (1) Employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary.

(2) Employers shall ensure that hearing protectors are worn:

(i) By an employee who is required by paragraph (b)(1) of this section to wear personal protective equipment; and

(ii) By any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:

(A) Has not yet had a baseline audiogram established pursuant to paragraph (g)(5)(ii); or

(B) Has experienced a standard threshold shift.

(3) Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer.

(4) The employer shall provide training in the use and care of all hearing protectors provided to employees.

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(5) The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

(j) *Hearing protector attenuation.* (1) The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the evaluation methods described in Appendix B: *Methods for Estimating the Adequacy of Hearing Protection Attenuation.*

(2) Hearing protectors must attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by paragraph (b) of this section.

(3) For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.

(4) The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

(k) *Training program.* (1) The employer shall institute a training program for all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels, and shall ensure employee participation in such program.

(2) The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes.

(3) The employer shall ensure that each employee is informed of the following:

(i) The effects of noise on hearing;

(ii) The purpose of hearing protectors, the advantages, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care; and

(iii) The purpose of audiometric testing, and an explanation of the test procedures.

(l) *Access to information and training materials.* (1) The employer shall make available to affected employees or their representatives copies of this standard and shall also post a copy in the workplace.

(2) The employer shall provide to affected employees any informational materials pertaining to the standard that are supplied to the employer by the Assistant Secretary.

(3) The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to this standard to the Assistant Secretary and the Director.

(m) *Recordkeeping*—(1) *Exposure measurements.* The employer shall maintain an accurate record of all employee exposure measurements required by paragraph (d) of this section.

(2) *Audiometric tests.* (i) The employer shall retain all employee audiometric test records obtained pursuant to paragraph (g) of this section:

(ii) This record shall include:

(A) Name and job classification of the employee;

(B) Date of the audiogram;

(C) The examiner's name;

(D) Date of the last acoustic or exhaustive calibration of the audiometer; and

(E) Employee's most recent noise exposure assessment.

(F) The employer shall maintain accurate records of the measurements of the background sound pressure levels in audiometric test rooms.

(3) *Record retention.* The employer shall retain records required in this paragraph (m) for at least the following periods.

(i) Noise exposure measurement records shall be retained for two years.

(ii) Audiometric test records shall be retained for the duration of the affected employee's employment.

(4) *Access to records.* All records required by this section shall be provided upon request to employees, former employees, representatives designated by the individual employee, and the Assistant Secretary. The provisions of 29 CFR 1910.20 (a)-(e) and (g)-(i) apply to access to records under this section.

(5) *Transfer of records.* If the employer ceases to do business, the employer shall transfer to the successor

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employer all records required to be maintained by this section, and the successor employer shall retain them for the remainder of the period prescribed in paragraph (m) (3) of this section.

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

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

(o) *Exemptions.* Paragraphs (c) through (n) of this section shall not apply to employers engaged in oil and gas well drilling and servicing operations.

(p) *Startup date.* Baseline audiograms required by paragraph (g) of this section shall be completed by March 1, 1984.

Appendix A: Noise Exposure Computation

This Appendix is Mandatory

I. Computation of Employee Noise Exposure

(1) Noise dose is computed using Table G-16a as follows:

(i) When the sound level, L, is constant over the entire work shift, the noise dose, D, in percent, is given by: $D = 100\ C/T$ where C is the total length of the work day, in hours, and T is the reference duration corresponding to the measured sound level, L, as given in Table G-16a or by the formula shown as a footnote to that table.

(ii) When the workshift noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

$$D = 100\ (C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level, and T_n indicates the reference duration for that level as given by Table G-16a.

(2) The eight-hour time-weighted average sound level (TWA), in decibels, may be computed from the dose, in percent, by means of the formula: $TWA = 16.61\ \log_{10}\ (D/100) + 90$. For an eight-hour workshift with the noise level constant over the entire shift, the TWA is equal to the measured sound level.

(3) A table relating dose and TWA is given in Section II.

Table G-16a

A-weighted sound level, L (decibel)	Reference duration, T (hour)
80	32
81	27.9
82	24.3
83	21.1
84	18.4
85	16
86	13.9
87	12.1
88	10.6
89	9.2
90	8
91	7.0
92	6.1
93	5.3
94	4.6
95	4
96	3.5
97	3.0
98	2.6
99	2.3
100	2
101	1.7
102	1.5
103	1.3
104	1.1
105	1
106	0.87
107	0.76
108	0.66
109	0.57
110	0.5
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25
116	0.22
117	0.19
118	0.16
119	0.14
120	0.125
121	0.11
122	0.095
123	0.082
124	0.072
125	0.063
126	0.054
127	0.047
128	0.041
129	0.036
130	0.031

In the above table the reference duration, T, is computed by

$$T = \frac{8}{2^{(L-90)/5}}$$

where L is the measured A-weighted sound level.

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II. Conversion Between "Dose" and "8-Hour Time-Weighted Average" Sound Level

Compliance with paragraphs (c)-(r) of this regulation is determined by the amount of exposure to noise in the workplace. The amount of such exposure is usually measured with an audiodosimeter which gives a readout in terms of "dose." In order to better understand the requirements of the amendment, dosimeter readings can be converted to an "8-hour time-weighted average sound level." (TWA).

In order to convert the reading of a dosimeter into TWA, see Table A-1, below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table G-16a. So, for example, a dose of 91 percent over an eight hour day results in a TWA of 89.3 dB, and, a dose of 50 percent corresponds to a TWA of 85 dB.

If the dose as read on the dosimeter is less than or greater than the values found in Table A-1, the TWA may be calculated by using the formula: $TWA = 16.61 \log_{10} (D/100) + 90$ where TWA = 8-hour time-weighted average sound level and D = accumulated dose in percent exposure.

TABLE A-1—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
10	73.4
15	76.3
20	78.4
25	80.0
30	81.3
35	82.4
40	83.4
45	84.2
50	85.0
55	85.7
60	86.3
65	86.9
70	87.4
75	87.9
80	88.4
81	88.5
82	88.6
83	88.7
84	88.7
85	88.8
86	88.9
87	89.0
88	89.1
89	89.2
90	89.2
91	89.3
92	89.4
93	89.5
94	89.6
95	89.6
96	89.7
97	89.8
98	89.9
99	89.9
100	90.0
101	90.1
102	90.1
103	90.2
104	90.3
105	90.4
106	90.4
107	90.5
108	90.6
109	90.6
110	90.7
111	90.8
112	90.8
113	90.9
114	90.9
115	91.1
116	91.1
117	91.1
118	91.2
119	91.3
120	91.3
125	91.6
130	91.9
135	92.2
140	92.4
145	92.7
150	92.9
155	93.2
160	93.4
165	93.6
170	93.8
175	94.0
180	94.2
185	94.4
190	94.6
195	94.8
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2

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TABLE A-1—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	103.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4
750	104.5
760	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1
820	105.2
830	105.3
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
999	106.6

APPENDIX B: METHODS FOR ESTIMATING THE ADEQUACY OF HEARING PROTECTOR ATTENUATION

This Appendix is Mandatory

For employees who have experienced a significant threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. Employers must select one of the following methods by which to estimate the adequacy of hearing protector attenuation.

The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. This Appendix describes four methods of using the NRR to determine whether a particular hearing protector provides adequate protection within a given exposure environment. Selection among the four procedures is dependent upon the employer's noise measuring instruments.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the "List of Personal Hearing Protectors and Attenuation Data," HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH methods #1, #2 and #3. The NRR described below is a simplification of NIOSH method #2. The most complex method is NIOSH method #1, which is probably the most accurate method since it uses the largest amount of spectral information from the individual employee's noise environment. As in the case of the NRR method described below, if one of the NIOSH methods is used, the selected method must be applied to an individual's noise environment to assess the adequacy of the attenuation. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

NOTE: The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

When using the NRR to assess hearing protector adequacy, one of the following methods must be used:

(i) When using a dosimeter that is capable of C-weighted measurements:

(A) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA (see Appendix A, II).

(B) Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(ii) When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:

(A) Convert the A-weighted dose to TWA (see Appendix A).

(B) Subtract 7 dB from the NRR.

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(C) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iii) When using a sound level meter set to the A-weighting network:

(A) Obtain the employee's A-weighted TWA.

(B) Subtract 7 dB from the NRR, and subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iv) When using a sound level meter set on the C-weighting network:

(A) Obtain a representative sample of the C-weighted sound levels in the employee's environment.

(B) Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.

(v) When using area monitoring procedures and a sound level meter set to the A-weighing network.

(A) Obtain a representative sound level for the area in question.

(B) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.

(vi) When using area monitoring procedures and a sound level meter set to the C-weighting network:

(A) Obtain a representative sound level for the area in question.

(B) Subtract the NRR from the C-weighted sound level for that area.

Appendix C: Audiometric Measuring Instruments

This Appendix is Mandatory

1. In the event that pulsed-tone audiometers are used, they shall have a tone on-time of at least 200 milliseconds.

2. Self-recording audiometers shall comply with the following requirements:

(A) The chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least ¼ inch. Additional increments are optional. The audiogram pen tracings shall not exceed 2 dB in width.

(B) It shall be possible to set the stylus manually at the 10-dB increment lines for calibration purposes.

(C) The slewing rate for the audiometer attenuator shall not be more than 6 dB/sec except that an initial slewing rate greater than 6 dB/sec is permitted at the beginning of each new test frequency, but only until the second subject response.

(D) The audiometer shall remain at each required test frequency for 30 seconds (± 3 seconds). The audiogram shall be clearly marked at each change of frequency and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than ± 3 seconds.

(E) It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

Appendix D: Audiometric Test Rooms

This Appendix is Mandatory

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D-1 when measured by equipment conforming at least to the Type 2 requirements of American National Standard Specification for Sound Level Meters, S1.4-1971 (R1976), and to the Class II requirements of American National Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, S1.11-1971 (R1976).

Table D-1—Maximum Allowable Octave-Band Sound Pressure Levels for Audiometric Test Rooms

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

Appendix E: Acoustic Calibration of Audiometers

This Appendix is Mandatory

Audiometer calibration shall be checked acoustically, at least annually, according to the procedures described in this Appendix. The equipment necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by American Standard Specification for Audiometers, S3.6-1969.

(I) Sound Pressure Output Check

A. Place the earphone coupler over the microphone of the sound level meter and place the earphone on the coupler.

B. Set the audiometer's hearing threshold level (HTL) dial to 70 dB.

C. Measure the sound pressure level of the tones at each test frequency from 500 Hz through 6000 Hz for each earphone.

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D. At each frequency the readout on the sound level meter should correspond to the levels in Table E-1 or Table E-2, as appropriate, for the type of earphone, in the column entitled "sound level meter reading."

(2) Linearity Check.

A. With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.

B. Measure the sound levels in the coupler at each 10-dB decrement from 70 dB to 10 dB, noting the sound level meter reading at each setting.

C. For each 10-dB decrement on the audiometer the sound level meter should indicate a corresponding 10 dB decrease.

D. This measurement may be made electrically with a voltmeter connected to the earphone terminals.

(3) Tolerances

When any of the measured sound levels deviate from the levels in Table E-1 or Table E-2 by ± 3 dB at any test frequency between 500 and 3000 Hz, 4 dB at 4000 Hz, or 5 dB at 6000 Hz, an exhaustive calibration is advised. An exhaustive calibration is required if the deviations are greater than 15 dB or greater at any test frequency.

TABLE E-1—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-39 EARPHONES

Frequency, Hz	Reference threshold level for TDH-39 earphones, dB	Sound level meter reading, dB
500	11.5	81.5
1000	7	77
2000	9	79
3000	10	80
4000	9.5	79.5
6000	15.5	85.5

TABLE E-2—REFERENCE THRESHOLD LEVELS FOR TELEPHONICS—TDH-49 EARPHONES

Frequency, Hz	Reference threshold level for TDH-49 earphones, dB	Sound level meter reading, dB
500	13.5	83.5
1000	7.5	77.5
2000	11	81.0
3000	9.5	79.5
4000	10.5	80.5
6000	13.5	83.5

APPENDIX F: CALCULATIONS AND APPLICATION OF AGE CORRECTIONS TO AUDIOGRAMS

This Appendix Is Non-Mandatory

In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging to the change in hearing level by adjusting the most recent audiogram. If the employer chooses to adjust the audiogram, the employer shall follow the procedure described below. This procedure and the age correction tables were developed by the National Institute for Occupational Safety and Health in the criteria document entitled "Criteria for a Recommended Standard . . . Occupational Exposure to Noise," ((HSM)-11001).

For each audiometric test frequency;

(i) Determine from Tables F-1 or F-2 the age correction values for the employee by:

(A) Finding the age at which the most recent audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz;

(B) Finding the age at which the baseline audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz.

(ii) Subtract the values found in step (i)(B) from the value found in step (i)(A).

(iii) The differences calculated in step (ii) represented that portion of the change in hearing that may be due to aging.

EXAMPLE: Employee is a 32-year-old male. The audiometric history for his right ear is shown in decibels below.

Employee's age	Audiometric test frequency (Hz)				
	1000	2000	3000	4000	6000
26	10	5	5	10	5
27	0	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	10	20	10
31	5	10	20	15	15

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Employee's age	Audiometric test frequency (Hz)				
	1000	2000	3000	4000	6000
*32	5	10	10	25	20

The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.

(The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25). A retest audiogram has confirmed this shift. The contribution of aging to this change in hearing may be estimated in the following manner:

Go to Table F-1 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	2000	3000	4000	6000
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audiogram hearing threshold at 4000 Hz (22). Thus the age-corrected threshold shift would be 17 dB (as opposed to a threshold shift of 20 dB without age correction).

TABLE F-1—AGE CORRECTION VALUES IN DECIBELS FOR MALES

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	5	3	4	5	8
21	5	3	4	5	8
22	5	3	4	5	8
23	5	3	4	6	9
24	5	3	5	6	9
25	5	3	5	7	10
26	5	4	5	7	10
27	5	4	6	7	11

TABLE F-1—AGE CORRECTION VALUES IN DECIBELS FOR MALES—Continued

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
28	6	4	6	8	11
29	6	4	6	8	12
30	6	4	6	9	12
31	6	4	7	9	13
32	6	5	7	10	14
33	6	5	7	10	14
34	6	5	8	11	15
35	7	5	8	11	15
36	7	5	9	12	16
37	7	6	9	12	17
38	7	6	9	13	17
39	7	6	10	14	18
40	7	6	10	14	19
41	7	6	10	14	20
42	8	7	11	16	20
43	8	7	12	16	21
44	8	7	12	17	22
45	8	7	13	18	23
46	8	8	13	19	24
47	8	8	14	19	24
48	9	8	14	20	25
49	9	9	15	21	26
50	9	9	16	22	27
51	9	9	16	23	28
52	9	10	17	24	29
53	9	10	18	25	30
54	10	10	18	26	31
55	10	11	19	27	32
56	10	11	20	28	34
57	10	11	21	29	35
58	10	12	22	31	36
59	11	12	22	32	37
60 or older	11	13	23	33	38

TABLE F-2—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	7	4	3	3	6
21	7	4	4	3	6
22	7	4	4	4	6
23	7	5	4	4	7
24	7	5	4	4	7
25	8	5	4	4	7
26	8	5	5	4	8
27	8	5	5	5	8
28	8	5	5	5	8
29	8	5	5	5	9
30	8	6	5	5	9
31	8	6	6	5	9
32	9	6	6	6	10
33	9	6	6	6	10
34	9	6	6	6	10
35	9	6	7	7	11
36	9	7	7	7	11
37	9	7	7	7	12
38	10	7	7	7	12
39	10	7	8	8	12
40	10	7	8	8	13
41	10	8	8	8	13
42	10	8	9	9	13

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TABLE F-2—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES—Continued

Years	Audiometric Test Frequencies (Hz)				
	1000	2000	3000	4000	6000
43	11	8	9	9	14
44	11	8	9	9	14
45	11	8	10	10	15
46	11	9	10	10	15
47	11	9	10	11	16
48	12	9	11	11	16
49	12	9	11	11	16
50	12	10	11	12	17
51	12	10	12	12	17
52	12	10	12	13	18
53	13	10	13	13	18
54	13	11	13	14	19
55	13	11	14	14	19
56	13	11	14	15	20
57	13	11	15	15	20
58	14	12	15	16	21
59	14	12	16	16	21
60 or older	14	12	16	17	22

APPENDIX G: MONITORING NOISE LEVELS NON-MANDATORY INFORMATIONAL APPENDIX

This appendix provides information to help employers comply with the noise monitoring obligations that are part of the hearing conservation amendment.

WHAT IS THE PURPOSE OF NOISE MONITORING?

This revised amendment requires that employees be placed in a hearing conservation program if they are exposed to average noise levels of 85 dB or greater during an 8 hour workday. In order to determine if exposures are at or above this level, it may be necessary to measure or monitor the actual noise levels in the workplace and to estimate the noise exposure or "dose" received by employees during the workday.

WHEN IS IT NECESSARY TO IMPLEMENT A NOISE MONITORING PROGRAM?

It is not necessary for every employer to measure workplace noise. Noise monitoring or measuring must be conducted only when exposures are at or above 85 dB. Factors which suggest that noise exposures in the workplace may be at this level include employee complaints about the loudness of noise, indications that employees are losing their hearing, or noisy conditions which make normal conversation difficult. The employer should also consider any information available regarding noise emitted from specific machines. In addition, actual workplace noise measurements can suggest whether or not a monitoring program should be initiated.

HOW IS NOISE MEASURED?

Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter. A sound level meter is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday. If noise levels fluctuate, the amount of time noise remains at each of the various measured levels must be determined.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace. After appropriate sound level meter readings are obtained, people sometimes draw "maps" of the sound levels within different areas of the workplace. By using a sound level "map" and information on employee locations throughout the day, estimates of individual exposure levels can be developed. This measurement method is generally referred to as *area* noise monitoring.

A dosimeter is like a sound level meter except that it stores sound level measurements and integrates these measurements over time, providing an average noise exposure reading for a given period of time, such as an 8-hour workday. With a dosimeter, a microphone is attached to the employee's clothing and the exposure measurement is simply read at the end of the desired time period. A reader may be used to read-out the dosimeter's measurements. Since the dosimeter is worn by the employee, it measures noise levels in those locations in which the employee travels. A sound level meter can also be positioned within the immediate vicinity of the exposed worker to obtain an individual exposure estimate. Such procedures are generally referred to as *personal* noise monitoring.

Area monitoring can be used to estimate noise exposure when the noise levels are relatively constant and employees are not mobile. In workplaces where employees move about in different areas or where the noise intensity tends to fluctuate over time, noise exposure is generally more accurately estimated by the personal monitoring approach.

In situations where personal monitoring is appropriate, proper positioning of the microphone is necessary to obtain accurate measurements. With a dosimeter, the microphone is generally located on the shoulder and remains in that position for the entire workday. With a sound level meter, the microphone is stationed near the employee's head, and the instrument is usually held by an individual who follows the employee as he or she moves about.

Manufacturer's instructions, contained in dosimeter and sound level meter operating manuals, should be followed for calibration and maintenance. To ensure accurate results, it is considered good professional prac-

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tice to calibrate instruments before and after each use.

HOW OFTEN IS IT NECESSARY TO MONITOR NOISE LEVELS?

The amendment requires that when there are significant changes in machinery or production processes that may result in increased noise levels, remonitoring must be conducted to determine whether additional employees need to be included in the hearing conservation program. Many companies choose to remonitor periodically (once every year or two) to ensure that all exposed employees are included in their hearing conservation programs.

WHERE CAN EQUIPMENT AND TECHNICAL ADVICE BE OBTAINED?

Noise monitoring equipment may be either purchased or rented. Sound level meters cost about $500 to $1,000, while dosimeters range in price from about $750 to $1,500. Smaller companies may find it more economical to rent equipment rather than to purchase it. Names of equipment suppliers may be found in the telephone book (Yellow Pages) under headings such as: "Safety Equipment," "Industrial Hygiene," or "Engineers-Acoustical." In addition to providing information on obtaining noise monitoring equipment, many companies and individuals included under such listings can provide professional advice on how to conduct a valid noise monitoring program. Some audiological testing firms and industrial hygiene firms also provide noise monitoring services. Universities with audiology, industrial hygiene, or acoustical engineering departments may also provide information or may be able to help employers meet their obligations under this amendment.

Free, on-site assistance may be obtained from OSHA-supported state and private consultation organizations. These safety and health consultative entities generally give priority to the needs of small businesses. See the attached directory for a listing of organizations to contact for aid.

OSHA ONSITE CONSULTATION PROJECT DIRECTORY

State	Office and address	Contact
Alabama	Alabama Consultation Program, P.O Box 6005, University, Alabama 35486.	(205) 348-7136, Mr William Weems, Director.
Alaska	State of Alaska, Department of Labor, Occupational Safety & Health, 3301 Eagle St., Pouch 7-022, Anchorage, Alaska 99510.	(907) 276-5013, Mr. Stan Godsoe, Project Manager (Air Mail).
American Samoa	Service not yet available.	
Arizona	Consultation and Training, Arizona Division of Occupational Safety and Health, P.O. Box 19070, 1624 W. Adams, Phoenix, Ariz. 85005.	(602) 255-5795, Mr. Thomas Ramaley, Manager
Arkansas	OSHA Consultation, Arkansas Department of Labor, 1022 High St., Little Rock, Ark. 72202.	(501) 371-2992, Mr. George Smith, Project Director
California	CAL/OSHA Consultation Service, 2nd Floor, 525 Golden Gate Avenue, San Francisco, Calif. 94102.	(415) 557-2870, Mr. Emmett Jones, Chief.
Colorado	Occupational Safety & Health Section, Colorado State University, Institute of Rural Environmental Health, 110 Veterinary Science Building, Fort Collins, Colo. 80523.	(303) 491-6151, Dr Roy M. Buchan, Project Director.
Connecticut	Division of Occupational Safety & Health, Connecticut Department of Labor, 200 Folly Brook Boulevard, Wethersfield, Conn. 06109.	(203) 566-4550, Mr. Leo Alix, Director.
Delaware	Delaware Department of Labor, Division of Industrial Affairs, 820 North French Street, 6th Floor, Wilmington, Del. 19801.	(302) 571-3908, Mr. Bruno Salvadori, Director.
District of Columbia	Occupational Safety & Health Division, District of Columbia, Department Employment Services, Office of Labor Standards, 2900 Newton Street NE., Washington, D.C. 20018.	(202) 832-1230, Mr. Lorenzo M. White, Acting Associate Director.
Florida	Department of Labor & Employment Security, Bureau of Industrial Safety and Health, LaFayette Building, Room 204, 2551 Executive Center Circle West, Tallahassee, Fla. 32301.	(904) 488-3044, Mr. John C. Glenn, Administrator.
Georgia	Economic Development Division, Technology and Development Laboratory, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Ga. 30332.	(404) 894-3806, Mr. William C. Howard, Assistant to Director, Mr. James Burson, Project Manager.
Guam	Department of Labor, Government of Guam, 23548 Guam Main Facility, Agana, Guam 96921.	(671) 772-6291, Joe R. San Agustin, Director.

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OSHA ONSITE CONSULTATION PROJECT DIRECTORY—Continued

State	Office and address	Contact
Hawaii	Education and Information Branch, Division of Occupational Safety and Health, Suite 910, 677 Ala Moana, Honolulu, Hawaii 96813.	(808) 548-2511, Mr. Don Alper, Manager (Air Mail).
Idaho	OSHA Onsite Consultation Program, Boise State University, Community and Environmental Health, 1910 University Drive, Boise, Idaho 83725.	(208) 385-3929, Dr. Eldon Edmundson, Director.
Illinois	Division of Industrial Services, Dept. of Commerce and Community Affairs, 310 S Michigan Avenue, 10 Floor, Chicago, Ill 60601.	(800) 972-4140/4216 (Toll-free in State), (312) 793-3270, Mr. Stan Czwinski, Assistant Director.
Iowa	Bureau of Labor, 307 E. Seventh Street, Des Moines, Iowa 50319.	(515) 281-3606, Mr. Allen J. Meier, Commissioner.
Indiana	Bureau of Safety, Education and Training, Indiana Division of Labor, 1013 State Office Building, Indianapolis, Indiana 46204.	(317) 633-5845, Mr. Harold Mills, Director.
Kansas	Kansas Dept. of Human Resources, 401 Topeka Ave., Topeka, Kans. 66603.	(913) 296-4086, Mr. Jerry Abbott, Secretary
Kentucky	Education and Training, Occupational Safety and Health, Kentucky Department of Labor, 127 Building, 127 South, Frankfort, Ky 40601.	(502) 564-6895, Mr. Larry Potter, Director.
Louisiana	No services available as yet (Pending FY 83).	
Maine	Division of Industrial Safety, Maine Dept. of Labor, Labor Station 45, State Office Building, Augusta, Maine 04333.	(207) 289-3331, Mr. Lester Wood, Director.
Maryland	Consultation Services, Division of Labor & Industry, 501 St. Paul Place, Baltimore, Maryland 21202.	(301) 659-4210, Ms Ileana O'Brien, Project Manager, 7(c)(1) Agreement.
Massachusetts	Division of Industrial Safety, Massachusetts Department of Labor and Industries, 100 Cambridge Street, Boston, Massachusetts 02202.	(617) 727-3567, Mr. Edward Noseworthy, Project Director.
Michigan (Health)	Special Programs Section, Division of Occupational Health, Michigan Dept. of Public Health, 3500 N Logan, Lansing, Mich. 48909	(517) 373-1410, Mr. Irving Davis, Chief.
Michigan (Safety)	Safety Education & Training Division Bureau of Safety and Regulation, Michigan Department of Labor, 7150 Harris Drive, Box 30015, Lansing, Michigan 48909.	(517) 322-1809, Mr. Alan Harvie, Chief.
Minnesota	Training and Education Unit, Department of Labor and Industry, 5th Floor, 444 Lafayette Road, St. Paul, Minn. 55101.	(612) 296-2973, Mr. Timothy Tierney, Project Manager.
Mississippi	Division of Occupational Safety and Health, Mississippi State Board of Health, P.O. Box 1700, Jackson, Mississippi 39205.	(601) 982-6315, Mr. Henry L. Laird, Director.
Missouri	Missoun Department of Labor and Industrial Relations, 722 Jefferson Street, Jefferson City, Missouri 65101.	1-(800) 392-0208, (314) 751-3403, Ms. Paula Smith, Mr. Jim Brake
Montana	Montana Bureau of Safety & Health, Division of Workers Compensation, 815 Front Street, Helena, Montana 59601.	(406) 449-3402, Mr. Ed Gatzemeier, Chief.
Nebraska	Nebraska Department of Labor, State House Station, State Capitol, P.O. Box 94600, Lincoln, Nebraska 68509.	475-8451 Ext. 258, Mr. Joseph Carroll, Commissioner.
Nevada	Department of Occupational Safety and Health, Nevada Industrial Commission, 515 E. Musser Street, Carson City, Nev. 89714.	(702) 885-5240, Mr. Allen Traenkner, Director.
New Hampshire	For information contact	Office of Consultation Programs, Room N3472 200 Constitution Avenue, N.W. Washington, D.C. 20210, Phone: (202) 523-8985.
New Jersey	New Jersey Department of Labor and Industry Division of Work Place Standards, CN-054, Trenton, New Jersey 08625.	(609) 292-2313, FTS-8-477-2313, Mr. William Clark, Assistant Commissioner.
New Mexico	OSHA Consultation, Health and Environment Department, Environmental Improvement Division, Occupational Health & Safety Section, 4215 Montgomery Boulevard, NE., Albuquerque, New Mexico 87109.	(505) 842-3387, Mr. Albert M. Stevens, Project Manager.
New York	Division of Safety and Health, New York State Department of Labor, 2 World Trade Center, Room 6995, New York, New York 10047.	(212) 488-7746/7, Mr. Joseph Alleva, Project Manager, DOSH.

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OSHA ONSITE CONSULTATION PROJECT DIRECTORY—Continued

State	Office and address	Contact
North Carolina	Consultation Services, North Carolina Department of Labor, 4 West Edenton Street, Raleigh, N.C. 27601.	(919) 733-4885, Mr. David Pierce, Director.
North Dakota	Division of Environmental Research, Department of Health, Missouri Office Building, 1200 Missouri Avenue, Bismarck, N. Dak. 58505.	(701) 224-2348, Mr. Jay Crawford, Director.
Ohio	Department of Industrial Relations, Division of Onsite Consultation, P.O. Box 825, 2323 5th Avenue, Columbus, Ohio 43216.	(800) 282-1425 (Toll-free in State), (614) 466-7485, Mr. Andrew Doehrel, Project Manager.
Oklahoma	OSHA Division, Oklahoma Department of Labor, State Capitol, Suite 118, Oklahoma City, Okla. 73105.	(405) 521-2461, Mr. Charles W. McGlon, Director.
Oregon	Consultative Section, Department of Workers' Compensation, Accident Prevention Division, Room 102, Building 1, 2110 Front Street NE., Salem, Oregon 97310	(503) 378-2890, Mr. Jack Buckland, Supervisor.
Pennsylvania	For information contact	Office of Consultation Programs, Room N3472, 200 Constitution Avenue NW., Washington, D.C. 20210, Phone: (202) 523-8985.
Puerto Rico	Occupational Safety & Health, Puerto Rico Department of Labor and Human Resources, 505 Munoz Rivera Ave., 21st Floor, Hato Rey, Puerto Rico 00919.	(809) 754-2134, Mr. John Cinque, Assistant Secretary, (Air Mail).
Rhode Island	Division of Occupational Health, Rhode Island Department of Health, The Cannon Building, 206 Health Department Building, Providence, R.I. 02903.	(401) 277-2438, Mr. James E. Hickey, Chief.
South Carolina	Consultation and Monitoring, South Carolina Department of Labor, P.O. Box 11329, Columbia, S.C. 29211.	(803) 758-8921, Mr. Robert Peck, Director, 7(c)(1), Project.
South Dakota	South Dakota Consultation Program, South Dakota State University, S.T.A.T.E.-Engineering Extension, 201 Pugsley Center-SDSO, Brookings, S. Dak. 57007.	(605) 688-4101, Mr. James Ceglian, Director.
Tennessee	OSHA Consultative Services, Tennessee Department of Labor, 2nd Floor, 501 Union Building, Nashville, Tennessee 37219.	(615) 741-2793, Mr. L. H. Craig Director.
Texas	Division of Occupational Safety and State Safety Engineer, Texas Department of Health and Resources, 1100 West 49th Street, Austin, Texas 78756.	(512) 458-7287, Mr. Walter G. Martin, P.E. Director.
Trust Territories	Service not yet available.	
Utah	Utah Job Safety and Health Consultation Service, Suite 4004, Crane Building, 307 West 200 South, Salt Lake City, Utah 84101.	(801) 533-7927/8/9, Mr. H. M. Bergeson, Project Director.
Vermont	Division of Occupational Safety and Health, Vermont Department of Labor and Industry, 118 State Street, Montpelier, VL 05602.	(802) 828-2765, Mr. Robert Mcleod, Project Director.
Virginia	Department of Labor and Industry, P.O. Box 12064, 205 N. 4th Street, Richmond, Va. 23241.	(804) 786-5875, Mr. Robert Beard, Commissioner.
Virgin Islands	Division of Occupational Safety and Health, Virgin Islands Department of Labor, Lagoon Street, Room 207, Frederiksted, Virgin Islands 00840.	(809) 772-1315, Mr. Louis Llanos, Deputy Director-DOSH.
Washington	Department of Labor and Industry, P.O. Box 207, Olympia, Wash. 98504.	(206) 753-6500, Mr. James Sullivan, Assistant Director.
West Virginia	West Virginia Department of Labor, Room 451B, State Capitol, 1900 Washington Street, Charleston, W. Va. 25305.	FTS 8-885-7890, Mr. Lawrence Barker, Commissioner.
Wisconsin (Health)	Section of Occupational Health, Department of Health and Social Services, P.O. Box 309, Madison, Wisconsin 53701.	(608) 266-0417, Ms. Patricia Natzke, Acting Chief.
Wisconsin (Safety)	Division of Safety and Buildings, Department of Industry, Labor and Human Relations, 1570 E. Moreland Blvd., Waukesha, Wis. 53186.	(414) 544-8686, Mr. Richard Michalski, Supervisor.
Wyoming	Wyoming Occupational Health and Safety Department, 200 East 8th Avenue, Cheyenne, Wyo. 82002.	(307) 777-7786, Mr. Donald Owsley, Health and Safety Administrator.

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Appendix H: Availability of Referenced Documents

Paragraphs (c) through (o) of 29 CFR 1910.95 and the accompanying appendices contain provisions which incorporate publications by reference. Generally, the publications provide criteria for instruments to be used in monitoring and audiometric testing. These criteria are intended to be mandatory when so indicated in the applicable paragraphs of § 1910.95 and appendices.

It should be noted that OSHA does not require that employers purchase a copy of the referenced publications. Employers, however, may desire to obtain a copy of the referenced publications for their own information.

The designation of the paragraph of the standard in which the referenced publications appear, the titles of the publications, and the availability of the publications are as follows:

Paragraph designation	Referenced publication	Available from—
Appendix B	"List of Personal Hearing Protectors and Attenuation Data," HEW Pub No. 76-120, 1975. NTIS-PB267461.	National Technical Information Service, Port Royal Road, Springfield, VA 22161.
Appendix D	"Specification for Sound Level Meters," S1.4-1971 (R1976).	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
§ 1910.95(k)(2), appendix E	"Specifications for Audiometers," S3.6-1969.	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
Appendix D	"Specification for Octave, Half-Octave and Third-Octave Band Filter Sets," S1.11-1971 (R1976)	Back Numbers Department, Dept. STD, American Institute of Physics, 333 E. 45th St., New York, NY 10017; American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

The referenced publications (or a microfiche of the publications) are available for review at many universities and public libraries throughout the country. These publications may also be examined at the OSHA Technical Data Center, Room N2439, United States Department of Labor, 200 Constitution Avenue, NW., Washington, D.C. 20210, (202) 523-9700 or at any OSHA Regional Office (see telephone directories under United States Government—Labor Department).

Appendix I: Definitions

These definitions apply to the following terms as used in paragraphs (c) through (n) of 29 CFR 1910.95.

Action level—An 8-hour time-weighted average of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of fifty percent.

Audiogram—A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

Audiologist—A professional, specializing in the study and rehabilitation of hearing, who is certified by the American Speech-Language-Hearing Association or licensed by a state board of examiners.

Baseline audiogram—The audiogram against which future audiograms are compared.

Criterion sound level—A sound level of 90 decibels.

Decibel (dB)—Unit of measurement of sound level.

Hertz (Hz)—Unit of measurement of frequency, numerically equal to cycles per second.

Medical pathology—A disorder or disease. For purposes of this regulation, a condition or disease affecting the ear, which should be treated by a physician specialist.

Noise dose—The ratio, expressed as a percentage, of (1) the time integral, over a stated time or event, of the 0.6 power of the measured SLOW exponential time-averaged, squared A-weighted sound pressure and (2) the product of the criterion duration (8 hours) and the 0.6 power of the squared sound pressure corresponding to the criterion sound level (90 dB).

Noise dosimeter—An instrument that integrates a function of sound pressure over a period of time in such a manner that it directly indicates a noise dose.

Otolaryngologist—A physician specializing in diagnosis and treatment of disorders of the ear, nose and throat.

Representative exposure—Measurements of an employee's noise dose or 8-hour time-weighted average sound level that the employers deem to be representative of the exposures of other employees in the workplace.

Sound level—Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pres-

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TABLE G-17—NEUTRON FLUX DOSE EQUIVALENTS—Continued

Neutron energy (million electron volts (Mev))	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm²)	Average flux to deliver 100 millirem in 40 hours (neutrons/cm² per sec.)
10	24×10^4	17
10 to 30	14×10^4	10

(8) For determining exposures to X- or gamma rays up to 3 Mev., the dose limits specified in this section may be assumed to be equivalent to the "air dose". For the purpose of this section "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dosage rate.

(b) *Exposure of individuals to radiation in restricted areas.* (1) Except as provided in paragraph (b)(2) of this section, no employer shall possess, use, or transfer sources of ionizing radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from sources in the employer's possession or control a dose in excess of the limits specified in Table G-18:

TABLE G-18

	Rems per calendar quarter
Whole body: Head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
Hands and forearms, feet and ankles	8¾
Skin of whole body	½

(2) An employer may permit an individual in a restricted area to receive doses to the whole body greater than those permitted under subparagraph (1) of this paragraph, so long as:

(i) During any calendar quarter the dose to the whole body shall not exceed 3 rems; and

(ii) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rems, where "N" equals the individual's age in years at his last birthday; and

(iii) The employer maintains adequate past and current exposure records which show that the addition of such a dose will not cause the individual to exceed the amount authorized in this subparagraph. As used in this subparagraph "Dose to the whole body" shall be deemed to include any dose to the whole body, gonad, active bloodforming organs, head and trunk, or lens of the eye.

(3) No employer shall permit any employee who is under 18 years of age to receive in any period of one calendar quarter a dose in excess of 10 percent of the limits specified in Table G-18.

(4) "Calendar quarter" means any 3-month period determined as follows:

(i) The first period of any year may begin on any date in January: *Provided,* That the second, third, and fourth periods accordingly begin on the same date in April, July, and October, respectively, and that the fourth period extends into January of the succeeding year, if necessary to complete a 3-month quarter. During the first year of use of this method of determination, the first period for that year shall also include any additional days in January preceding the starting date for the first period; or

(ii) The first period in a calendar year of 13 complete, consecutive calendar weeks; the second period in a calendar year of 13 complete, consecutive weeks; the third period in a calendar year of 13 complete, consecutive calendar weeks; the fourth period in a calendar year of 13 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included within the last complete calendar week of that year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included within the last complete calendar week of the previous year; or

(iii) The four periods in a calendar year may consist of the first 14 complete, consecutive calendar weeks; the next 12 complete, consecutive calendar weeks, the next 14 complete, consecutive calendar weeks, and the last 12 complete, consecutive calendar weeks.

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