CHEMICAL HYGIENE PLAN

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OCCUPATIONAL EXPOSURES TO HAZARDOUS CHEMICALS IN LABORATORIES (29 CFR 1910.1450) CHEMICAL HYGIENE PLAN

1.0 INTRODUCTION

1.1 OSHA Regulations

On January 31, 1990, the Occupational Safety and Health Administration (OSHA) promulgated a final rule entitled Occupational Exposures to Hazardous Chemicals in Laboratories (commonly known as "The Laboratory Standard" - see Appendix A). The basis for this standard is a determination that laboratories differ from industrial operations in their use and handling of hazardous chemicals and that a different approach than that found in OSHA's substance specific health standards is warranted to protect workers. This standard does not establish new exposure limits, but sets other performance provisions designed to protect laboratory workers from potential hazards in their work environment.

1.2 Purpose

The purpose of this model Chemical Hygiene Plan is to define work practices and procedures to help ensure that Laboratory Workers at IUPUI are protected from health and safety hazards associated with the hazardous chemicals with which they work.

1.3 Applicability

The Laboratory Standard applies to all employees engaged in the laboratory use of hazardous chemicals. Laboratory use of hazardous chemicals is defined as the use or handling of chemicals in which all of the following conditions are met:

- Chemical manipulations are carried out on a "laboratory scale". Laboratory scale is defined as work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. This definition excludes those workplaces whose function is to produce commercial quantities of materials.

- Multiple chemical procedures or chemicals are used.

- The procedures involved are not part of a production process, nor in any way simulate a production process.

This standard does not apply to:

- Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

- Laboratory uses of hazardous chemicals which provide no potential for employee exposure.

Where the standard does apply, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 20 CFR part 1910, subpart Z, except as follows:

- For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the action level (or in the absence of an action level, the PEL) is routinely exceeded. - See Appendix B.

- Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

- Where the action level (or in the absence of an action level, the PEL) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements, the employee exposure monitoring and medical monitoring requirements of this standard shall apply.

Any substance specific standard can require coverage to remain under that standard rather than under the laboratory standard. In the absence of a statement of preemption in a substance specific standard, the determination of whether the laboratory standard applies must be dependent on both "laboratory use" and "laboratory scale" criteria. Where these criteria are met, the laboratory standard applies.

1.4 Chemical Hygiene Plan Coverage

The Chemical Hygiene Plan is the written program that contains policies and procedures for the safe use of hazardous chemicals. Major components of the plan include:

- Employee information and training
- Hazard identification
- Personal exposure monitoring

- Medical surveillance
- Standard operating procedures
- Personal protective equipment
- Containment and engineering controls

1.5 Definitions

ACGIH American Conference of Governmental Industrial Hygienists.

Action level A concentration designated in [the OSHA (29 CFR) Laboratory Standard for a specific substance, calculated as an eight-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

ANSI American National Standards Institute.

Chemical Hygiene Officer An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Chemical Hygiene Plan A written program developed and implemented by the employer which (1) sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace, and (2) meets the requirements of 29 CFR 1910.1450(e).

CHO The Chemical Hygiene Officer, a member of the IUPUI Department of Environmental Health and Safety.

CHP Chemical Hygiene Plan.

Designated area An area which may be used for work with select carcinogens, reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

EHS The IUPUI Department of Environmental Health and Safety

EPA Environmental Protection Agency.

Hazardous chemical 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 systems, and agents which damage the lungs, skin, eyes, or mucous membranes. (See also definitions of specific and physical hazards.)

Laboratory OSHA defines a laboratory as "a workplace where relatively small quantities of hazardous chemicals are used on a non-productive basis".

Lab Workers The Laboratory Workers referred to in the Lab Standard are employees. OSHA defines an employee as "an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments." An example of a Laboratory Worker would be a University teaching assistant, research assistant or faculty member instructing an academic lab. OSHA would not consider students in an academic laboratory employees. However, as a matter of university policy, the principles outlined in this Chemical Hygiene Plan will apply to students in laboratories. Also included, will be visiting professors and volunteers that might be working in the lab. Thus, Laboratory Supervisors must ensure that these groups that are in their laboratories are adequately instructed in safe laboratory procedures.

OSHA The Occupational Safety and Health Administration.

Oxidizer A chemical, other than a blasting agent or explosive as defined in [OSHA Regulations (Standards-29 CFR) - 1910.109a], that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

NFPA National Fire Protection Association.

PEL Permissible exposure limit. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation.

Physical hazard A combustible liquid, compressed gas, oxidizer, or organic peroxide; or a material with explosive, flammable, pyrophoric, unstable (reactive), or water-reactive properties.

PPE Personal protective equipment.

PI The Principal Investigator (or the Laboratory or Instructional Supervisor).

Reproductive toxin A chemical which affects the reproductive capabilities, or damages the chromosomes (mutation) or fetus (teratogenesis).

Safety Coordinator A safety coordinator (SC) will be designated for each school, department, or other subdivision by the dean, chairman, or director to serve as liaison to

EHS.

Select carcinogen Any substance which meets one of the following criteria: (1) it is regulated by OSHA as a carcinogen; or (2) it is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or (3) it is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or (4) it is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (a) after inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3; (b) after repeated skin application of less than 300 (mg/kg of body weight) per week; or (c) after oral dosages of less than 50 mg/kg of body weight per day.

TLV Threshold limit value.

SOP Standard operating procedure

2.0 CHEMICAL HYGIENE RESPONSIBILITIES

2.1 Background

IUPUI is committed to providing a safe and healthful environment for all persons associated with the institution. The university intends to be a role model in its environmental stewardship, health protection and safety standards and its compliance with all laws and regulations relating to the environment, health and safety. Management, faculty, staff, and students are asked to support these goals in all university activities and the University administration will provide the necessary resources to achieve these goals.

A vast array of educational activities and research utilizing hazardous materials is conducted at the university that requires cooperation of all parties involved to ensure that such activities are conducted safely with regard to workers, students, the community, and the environment. The following outlines specific responsibilities associated with laboratory safety and this Chemical Hygiene Plan.

2.2 IUPUI Department of Environmental Health and Safety

The Department of Environmental Health and Safety (EHS) is responsible for providing overall administrative guidance and supervision for the Chemical Hygiene Plan (CHP). Specific responsibilities of EHS include:

- Provide training for managers, supervisors, and safety coordinators concerning requirements of the program and their responsibilities.

- Provide guidance for the preparation of procedures, chemical inventories, and training programs required by the CHP.

- Validate employee training.

- Maintain a master file of documentation and records associated with the CHP, including training, personal exposure, medical surveillance, chemical inventories, and material safety data sheets (MSDSs).

- Handle MSDS requests.

2.3 Chemical Hygiene Officer

The Chemical Hygiene Officer (CHO) is an employee who is qualified by training or experience, to provide technical guidance for the continuing implementation of the CHP. The Chemical Hygiene Officer for IUPUI is the Laboratory Safety Manager. Specific responsibilities of the CHO include:

- Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices.

- Monitor procurement and use of chemicals in the lab, including determining that facilities and training levels are adequate for the chemicals in use.

- Perform annual chemical hygiene and housekeeping inspections including inspections of emergency equipment.

- Maintain current knowledge concerning the legal requirements of regulated substances in the laboratory.

- Review and improve the Chemical Hygiene Plan on an annual basis.

- Maintain overall responsibility for laboratory safety.

- Monitor employee knowledge and adherence to the chemical hygiene rules.

- Aid in determining the proper level of personal protective equipment.

- Ensure that appropriate training has been provided to employees.

2.4 Managers and Supervisors

Lab managers and supervisors are responsible for maintaining safe operations in their labs on a daily basis. Specific responsibilities include:

- Attend training provided by EHS concerning the requirements of this program and their responsibilities, or send their representative who shall be the safety coordinator (SC) for the work area.

- Ensure that the Chemical Hygiene Plan is customized for their lab and incorporated into routine training sessions for their respective work areas. This program must be written, applicable to the individual chemical process, and at least as stringent as the requirements of this document.

- Include standard operating procedures for specific laboratory procedures in CHP Section 3.2.

- Ensure employee training at the time of initial assignment to the area, whenever a new hazard is introduced to the area or when the employee is reassigned to an area using new or different materials and/or processes.

- Provide appropriate personal protective equipment and require its proper use and maintenance.

- Ensure an inventory is completed for all chemicals used in their work areas following the instructions provided by EHS.

- Review and understand MSDSs on materials used by employees under their direct supervision and inform employees as new MSDSs become available.

- Ensure MSDSs are available in the work area and are readily accessible to employees.

- Ensure that employee requests for MSDSs and other materials are promptly handled, requesting any necessary information or help from EHS.

- Ensure that **all** containers of hazardous materials are labeled with the chemical name or trade name.

- Ensure that safe and healthful work conditions are maintained.

2.5 Safety Coordinator

A safety coordinator (SC) will be designated for each school, department, or other subdivision by the dean, chairman, or director to serve as liaison to EHS and the CHO. Responsibilities of the SC include:

- Conduct training on the hazards of chemicals used by lab workers in their labs.
- Ensure that training is documented using the Chemical Hygiene Plan Training Attendance Record (Appendix C). Keep a copy of the record for the departmental file and send the original to EHS.
- Provide information about chemical hazards to contract employees or IUPUI maintenance employees working in the area.
- Serve as a conduit for information between laboratories in their area and EHS and the CHO.
- Assist EHS or CHO with the collection of chemical inventory information.
- Distribute Laboratory Safety Surveys to appropriate investigators and ensure that all required deficiencies have been corrected.

2.6 Laboratory Workers

Responsibilities include the following:

- Report any suspected job-related injuries or illnesses to the Laboratory Supervisor and seek treatment immediately
- Refrain from the operation of any equipment or instrumentation without proper instruction and authorization
- Remain aware of the hazards of the chemicals in the lab and how to handle hazardous chemicals safely
- Request information and training when unsure how to handle a hazardous chemical or procedure
- Follow all safety and health standards and rules.
- Report all hazardous conditions to the supervisor.

- Wear or use prescribed protective equipment.
- Refrain from operating equipment that has safety defects.
- Attend training sessions on the Chemical Hygiene Program.
- Keep informed about chemicals used in the lab.

3.0 OPERATING PROCEDURES

3.1 Purpose

The Lab Standard requires operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals. This Plan represents a minimum set of guidelines for IUPUI laboratories handling hazardous chemicals.

3.2 General Standard Operating Procedures

The General Standard Operating Procedures are fundamental safety precautions which should be familiar to all lab users. These practices should be followed at all times.

3.2.1 Chemical Procurement

- The decision to procure a chemical shall be a commitment to handle and use the chemical properly from initial receipt to ultimate disposal.
- Prior to ordering a chemical, the user must determine that appropriate containment and personal protective equipment are available for its use. The Chemical Hygiene Officer will assist in this determination.
- Personnel who receive chemical shipments shall be knowledgeable of the proper procedures for receipt and Department of Transportation (DOT) compliance. Chemical containers shall not be accepted without accompanying labels, material safety data sheets and packaging in accordance with all appropriate regulations. All chemical shipments should be dated when received and opened.

3.2.2 Chemical Storage

- Received chemicals shall be immediately moved to the designated storage area. Large glass containers shall be placed in carrying containers or shipping containers during transportation.

- The storage area shall be well-illuminated, with all chemical storage maintained below eye level. Large bottles shall be stored no more than two feet from ground level.

- Chemicals shall be segregated by hazard classification and compatibility in a well-identified area, with local exhaust ventilation.

- Highly toxic chemicals shall be stored in unbreakable secondary containers.

- When chemicals are taken from the storage area, they shall be placed in an outside container or bucket.

- Storage of chemicals at the lab bench or other work areas shall be limited to those amounts necessary for work currently in progress.

- The amounts of chemicals at the lab bench shall be as small as practical.

- Stored chemicals shall be examined annually by the Chemical Hygiene Officer or his designee for replacement, deterioration, and container integrity. The inspection should determine whether any corrosion, deterioration, or damage has occurred to the storage facility as a result of leaking chemicals.

- Periodic inventories of chemicals outside the storage area shall be conducted by the Chemical Hygiene Officer or his designee. Unneeded items shall be properly discarded or returned to the storage area.

3.2.3 Chemical Handling

- Each laboratory employee with the training, education and resources provided by supervision, shall develop and implement work habits consistent with this CHP to minimize personal and co-worker exposure to the chemicals in the laboratory. Based on the realization that all chemicals inherently present hazards in certain conditions, exposure to <u>all</u> chemicals shall be minimized.

- General precautions which shall be followed for the handling and use of all chemicals include:

- Skin contact with all chemicals shall be avoided.

- All employees shall wash all areas of exposed skin prior to leaving the laboratory.

- Mouth suction for pipeting or starting a siphon is prohibited.

- Eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present is prohibited.

- Storage, handling and consumption of food or beverages shall not occur in chemical storage areas or refrigerators. Glassware and utensils used for laboratory operations shall not be used for food or drink consumption or preparation.

- Any chemical mixture shall be assumed to be at least as toxic as its most toxic component.

- Substances of unknown toxicity shall be assumed to be toxic.

- Laboratory employees shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.

- In all cases of chemical exposure, neither the Permissible Exposure Limits (PELs) of OSHA (see Appendix B) or the Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH) shall be exceeded.

3.2.4 Laboratory Equipment and Glassware

Each employee shall keep the work area clean and uncluttered. At the completion of each work day or operation, the work area shall be thoroughly cleaned and all equipment properly cleaned and stored. In addition, the following procedures shall apply to the use of laboratory equipment:

- All laboratory equipment shall be used only for its intended purpose.

- All glassware will be handled and stored with care to minimize breakage; all broken glassware will be immediately disposed of in an appropriately labeled broken glass container constructed with corrugated cardboard or other puncture-resistant material.

- All evacuated glass apparatus shall be shielded to contain chemicals and glass fragments should implosion occur.

- All laboratory equipment shall be inspected by the user on a periodic basis for safety defects, and replaced or repaired as necessary.

3.2.5 Personal Protective Equipment

- Safety glasses meeting ANSI Z87.1 are required for employees and visitors in laboratories so designated, and will be worn at all times when in the laboratory in a Class 3 eye protection laboratory.

- Safety glasses meeting ANSI Z87.1 are required for employees and visitors in laboratories designated as a Class 2 eye protection laboratory when an eye hazard is present in the laboratory.

- Chemical goggles and a full face shield (if necessary) shall be worn during chemical transfer and handling operations as procedures dictate.

- Shorts, sandals, perforated shoes, cloth sneakers and bare feet are prohibited.

- Lab coats provide adequate body protection for most operations in the laboratory. Laboratory coats will be laundered on a periodic basis (at least monthly). Laboratory coats shall be removed immediately upon discovery of significant contamination.

- Appropriate chemical-resistant gloves (see Section XVII of the Reference Manual) shall be worn at all times when there may be skin contact with chemicals. Used gloves shall be inspected and washed prior to reuse. Damaged or deteriorated gloves will be immediately replaced. Gloves shall be washed prior to removal from the hands.

- Thermal-resistant gloves shall be worn for operations involving the handling of heated materials and cryogenic fluids. Thermal-resistant gloves shall be non-asbestos and shall be replaced when damaged or deteriorated.

- Respirator usage shall comply with the OSHA Respiratory Protection Standard, 29 CFR 1910.134, and the IUPUI Respiratory Protection Program.

3.2.6 Personal Work Practices

- Laboratory supervision must ensure that each employee knows and follows the rules and procedures established in this plan.

- All employees shall be alert for unsafe practices and conditions in the laboratory and shall immediately report such practices and/or conditions to the laboratory supervisor. The supervisor must correct unsafe practices and/or conditions promptly.

- Long hair and loose-fitting clothing shall be confined close to the body to avoid being caught in moving machine/equipment parts.

- Use only those chemicals appropriate for the ventilation system.

- Avoid unnecessary exposure to all chemicals by any route.

- Do not smell or taste any chemicals.

- Working alone in the laboratory is not appropriate; if this is necessary, arrange for periodic checks by personnel in adjacent laboratories.

- Seek information and advice from knowledgeable persons, standards and codes about the hazards present in the laboratory. Plan operations, equipment and protective measures accordingly.

- Use engineering controls in accordance with Section 5.0.

- Inspect personal protective equipment prior to use, and wear appropriate protective equipment as procedures dictate and when necessary to avoid exposure.

3.2.7 Labeling

- All containers in the laboratory shall be labeled. This includes chemical containers and waste containers. The label shall be informative and durable, and at a minimum, will identify contents, source, date received and opened, and indication of hazard.

- Secondary containers shall be labeled by the individual using the container.

- All food items used in the lab shall be labeled "Not for human consumption".

- All microwaves used in the laboratory shall be labeled "Not for food use".

- All refrigerators and freezers shall be labeled "No food, drinks or flammables" unless it is a fire safe refrigerator. If it is a fire safe refrigerator it shall be labeled with "No food or drinks".

- Existing labels on incoming containers shall not be removed or defaced unless appropriately relabeled immediately with the required information.

- The labeling program shall be periodically inspected by the Chemical Hygiene Officer or his designee to ensure that labels are attached and in good condition

3.3 Procedure-Specific Safety Procedures

Written laboratory procedures normally have a description of specific safety measures for that particular procedure. Lab workers should read and review those practices before beginning a procedure.

3.4 Special Procedures for Particularly Hazardous Substances

Special precautions shall be taken when performing laboratory work with any of the following inimical chemical categories: carcinogens, reproductive toxins, substances that have a high degree of acute toxicity, or chemicals whose toxic properties are unknown.

3.4.1 Inimical Chemical Categories

- Carcinogens - Both known and suspect cancer-causing chemicals reported in the latest edition of the National Toxicology Program's "Carcinogens Summary" (see Section VII of the Reference Manual).

- Reproductive Toxins - Chemicals including mutagens and teratogens identified as such by the Material Safety Data Sheet.

- Acute Toxicity Chemicals - Any substance for which the LD_{50} data described in the applicable MSDS (or other literature source) cause the substance to be classified as a level 3 or 4 health hazard according to the HMIS system (see Section XIII of the Reference Manual).

- Chemicals Whose Toxic Properties are Unknown - Chemicals for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.

3.4.2 Precautions for Inimical Chemical Use

- Allow only those persons specifically trained to work with inimical chemicals to work with those chemicals.

- Designated Area - A hood, glove box, portion of a laboratory, or an entire laboratory must be designated for inimical chemical use.

- Designated areas shall be posted and their boundaries clearly marked. Posting shall include the identification of inimical chemicals used in the area.

- Access to the laboratory may be restricted during inimical chemical use by the laboratory supervisor or CHO.

- Suitable gloves and long sleeves shall be worn during use of inimical chemicals (see Section XVII of the Reference Manual).

- Use the smallest amount of chemical that is consistent with the requirements of the work to be done.

- Use high-efficiency particulate air (HEPA) filters or high-efficiency scrubber systems to protect vacuum lines and pumps.

- Decontaminate a designated area when work is completed.

- Store all inimical chemicals in locked and enclosed spaces at all times when not in use.

- Retain all inimical chemical wastes for disposal by EHS (see Section XIX of the Reference Manual).

3.5 Prior Approval for Laboratory Activities

Certain activities that present specific, foreseeable hazards for laboratories and their users may require prior approval from their department and/or the CHO. These activities include, sole occupancy of building, hazardous operations, use of new procedures or chemicals, and unattended operations.

3.5.1 Sole Occupancy of Building

Under normal circumstances, work should not be done in the laboratory when the only person in the building is the laboratory person performing the work. If this is necessary, periodic checks on that person should be made by personnel in adjacent buildings.

3.5.2 Hazardous Operations

All hazardous operations are to be performed during a time when at least two people are present at the laboratory. At no time shall a laboratory person, while working alone in the laboratory, perform work which is considered hazardous. The determination of hazardous operations shall be made by the laboratory supervisor and/or CHO.

3.5.3 New Procedures or Chemicals

Prior to the use of new procedures or chemicals, a review of potential hazards created must be undertaken within the department. The review should also be completed when there is a substantial change in the amount of chemicals used or a change in the equipment used in the procedure.

3.5.4 Unattended Operations

When laboratory operations are performed which will be unattended by laboratory personnel (continuous operations, overnight reactions, etc.), the following procedures will be employed:

- The laboratory supervisor will review work procedures to ensure the safe completion of the operation.
- An appropriate sign will be posted at all entrances to the laboratory.
- The overhead lights in the laboratory will be left on.
- Precautions shall be made for the interruption of utility services during the unattended operation (loss of water pressure, electricity, etc.).
- Containment will be provided in the event of unexpected hazardous material releases.
- Tubing for running water must be in good condition and secured at connections by clamps or wire.

4.0 CRITERIA FOR IMPLEMENTATION OF CONTROL MEASURES

4.1 Air Sampling

- Air sampling for evaluating employee exposure to chemical substances shall be conducted periodically or as indicated by specific codes or regulations.

- Upon addition of new chemicals or changes in control procedures, additional air sampling will be considered to determine the exposures.

- Air sampling will be conducted if there is reason to believe that exposure levels for regulated substances exceed the action level, or in the absence of an action level, the PEL.

- The results of air sampling studies performed in the laboratory are maintained by EHS.

4.2 Housekeeping

Each laboratory worker is directly responsible for the cleanliness of his or her work space, and jointly responsible for common areas of the laboratory. Laboratory management shall insist on the maintenance of housekeeping standards. The following procedures apply to housekeeping standards of the laboratory:

- The lab benches shall be kept clear of equipment and chemicals except those necessary for the work currently being performed.

- The work area shall be cleaned at the end of each operation or each day.

- All apparatus shall be thoroughly cleaned and returned to storage upon completion of usage.

- All floors, aisles, exits, fire extinguishing equipment, eye washes, electrical disconnects and other emergency equipment shall remain unobstructed.

- All labels shall face front.

- Chemical containers shall be clean, properly labeled and returned to storage upon completion of usage.

- All chemical wastes will be disposed of promptly in accordance with the waste disposal plan (see Section XIX of the Reference Manual).

4.3 Safety and Emergency Equipment

- Telephone numbers of emergency personnel, supervisors and other workers as deemed appropriate shall be posted and provided to EHS.

- All laboratory personnel will be aware of the location and proper use of fire safety and emergency equipment.

- Prior to the procurement of new chemicals, the Chemical Hygiene Officer or the laboratory supervisor shall verify that safety and emergency equipment are appropriate for such chemicals.

- Eye washes shall be inspected and flushed for 5 minutes weekly by laboratory employees. Showers shall be inspected by EHS at least annually. Records shall be maintained for eye wash and shower inspections.

- Location signs for safety and emergency equipment shall be posted.

5.0 ENGINEERING CONTROLS

5.1 Intent

The engineering controls installed in the laboratory are intended to minimize employee exposure to chemical and physical hazards in the workplace. These controls must be maintained in proper working order for this goal to be realized.

5.2 Modification

No modification of engineering controls will occur unless testing indicates that worker protection will continue to be adequate.

5.3 Improper Function

Improper function of engineering controls must be reported to the Chemical Hygiene Officer and to Campus Facility Services Trouble Line (278-1900) immediately. The system shall be taken out of service until proper repairs have been executed.

5.4 Usage

5.4.1 Laboratory Fume Hoods

The laboratory fume hoods shall be utilized for all chemical procedures which might result in release of hazardous chemical vapors or dust. As a general rule, the fume hood shall be used for all chemical procedures involving substances which are volatile and have a permissible exposure limit (PEL) less than 100 ppm or are flammable materials. The following work practices shall apply to the use of fume hoods:

- Confirm adequate hood ventilation performance prior to opening chemical containers inside the hood. An inward flow of air can be confirmed by holding a thin strip of tissue at the face of the hood and observing the movement of the paper.

- Keep the sash of the hood at or below the indicated maximum operating height except when adjustments within the hood are being made. At these times, maintain the sash height as low as possible.

- Storage of chemicals and equipment inside the hood shall be kept to a minimum.

- Minimize interference with the inward flow of air into the hood.

- Locate apparatus toward the rear of the hood and keep all work at least 6 inches inside the hood to prevent vapors from escaping.

- Do not place items against the back wall which will obstruct the baffles and impede the airflow.

- Leave the hood operating when it is not in active use if hazardous chemicals are contained inside the hood or if it is uncertain whether adequate general laboratory ventilation will be maintained when the hood is non-operational.

- The hood shall not be used as a means of disposal for volatile chemicals.

- The ventilation system shall be inspected annually by EHS. The hood face velocity shall be at least 80 feet per minute. A record of each inspection shall be maintained by the Chemical Hygiene Officer.

5.4.2 Glove Boxes and Isolation Rooms

The exhaust air from a glove box or isolation room will pass through HEPA filters or other treatment before release into the regular exhaust system.

5.4.3 Flammable Storage Cabinets

Cabinets designed for the safe storage of flammable chemicals can only do so if used and maintained properly. Cabinets are generally made of double-walled construction and are made of 18 gage steel. The doors are two inches above the base and the cabinet is liquid proof to that point. Two vents are provided on opposite sides of the cabinet and are equipped with flame-arrestor screens. Always read the manufacturer's information and follow prudent safety practices such as:

- Store only compatible materials inside the cabinet.
- Store chemicals of similar vapor density together when using mechanical ventilation (e.g., heavier than air vapors are vented through the bottom vent and lighter than air vapors through the top vent).
- Do not store paper or cardboard inside cabinets with the chemicals.
- Do not overload the cabinet.
- Do not store corrosives inside the cabinet.

6.0 EMPLOYEE INFORMATION AND TRAINING

6.1 Training Organization

All IUPUI employees working in a laboratory environment must attend the mandatory Laboratory Safety Training class. This class is offered monthly, and can also be offered at other dates by contacting the Environmental Health and Safety Department. This training fulfills the OSHA Laboratory Standard requirements.

6.2 Training Timing and Frequency

Information and training shall be provided to laboratory employees on the following basis:

- New employees shall complete the full training program.
- Current employees who have changed positions or are assigned to begin working in a laboratory must complete the full training program.
- All employees shall be informed of updated information via Lab Notes.

6.3 Training Components

This training shall include methods of detecting the presence of hazardous chemicals, physical and health hazards of chemicals in the lab, and measures employees can take to protect themselves from these hazards. The training shall present the details of the Chemical Hygiene Plan, and shall include:

- The contents of the OSHA laboratory standard, and its appendices.
- The location and availability of the Chemical Hygiene Plan.

- The physical and health hazards of chemicals in the work area.
- Signs and symptoms associated with exposure to the chemicals present in the laboratory.
- Location, availability, and how to use reference material on chemical hygiene including Material Safety Data Sheets.
- The criteria for selection and use of personal protective equipment and the limits of its protection.
- Emergency procedures and the location of emergency equipment.

6.4 Training Documentation

The safety coordinator is responsible for ensuring that all employees in their department, required per section 6.1, have attended the Laboratory Safety Training. All personnel attending the Laboratory Safety Training course will sign an attendance sheet. A copy of this record shall be maintained by the Chemical Hygiene Officer.

7.0 LABORATORY SIGNAGE

7.1 Introduction

The signage system is designed to fulfill regulatory signage requirements as well as alert lab users and visitors to specific hazards located in individual laboratories. The lab signs do not list every hazard associated with a lab and do not replace basic laboratory safety training or practice.

Accurate door postings facilitate emergency response actions by providing immediate information to firefighters, paramedics, and others. Incorrect postings may place others in danger and/or delay implementation of measures to control and minimize certain emergency situations (e.g., fire, explosion, etc.), thereby increasing the damage to the room and/or other portions of the building.

7.2 Hazard Assessment and Laboratory Signage Program (HALS)

HALS is a web based program designed to assist laboratory supervisors in identifying the hazards present in their laboratories and communicating this information to anyone who enters their labs. The laboratory PI or his representative can log onto the IUPUI

Environmental Health and Safety Website at www.ehs.iupui.edu and click on the link to the HALS program at http://www.ehs.iupui.edu/hals/home.asp.

The Laboratory PI or his representative will then complete an electronic profile of the laboratory, and the information is incorporated into a door sign. The sign lists the name of the principal investigator and the name of an alternate contact that are responsible for the room, along with corresponding contact numbers.

The PI must select the most important hazards in their lab area from a list of twelve hazard types (see section 7.2.1 for the Hazard Definition Tables), and then rate the risk level as "low", "moderate", or "high" for each hazard. For biological hazards present in the laboratory please choose from BSL1, BSL2 or BSL3. If radioactive materials are in use in the laboratory then please indicate "Present" on the pull down menu. Please note that you must have approval from Radiation Safety before a sign can be posted indicating radioactive materials in use. Please also indicate, using the drop down menu, if your laboratory eye classification is a class 1, class 2 or class 3.

The sign indicates any limitations on access, and also provides an area for you to type any additional warnings you would like posted.

All laboratory signs will automatically state "No Food or Drink allowed".

7.3 Hazard Definition Tables

Biohazard

Definition: Organisms or their products that may cause harm to humans or animals. Example: disease-causing microorganisms. Immuno-compromised individuals (who lack resistance to infection) may be at an increased risk of health effects from biohazards. These people should discuss their condition with their supervisors so that, if appropriate, additional precautions would be followed.

BSL1: Microbiology lab using microorganisms that do not cause disease in healthy adults. Examples: E. Coli bacteria, yeast "Biosafety Level 1".

BSL2: Organisms that can cause moderate to serious illness in healthy adults. Infections seldom occur via inhalation unless the organism is dispersed into the air as an aerosol. Infections readily occur from needle sticks or accidental contact with mucous membranes such as eyes and mouth. Ex: Human blood and body fluids, salmonella bacteria, hepatitis B. "Biosafety Level 2".

BSL3: Organisms that can cause serious illness or death in healthy adults. Exposure by inhalation is a risk from any sort of handling procedures or from spills or contaminated waste. Infections also readily occur from needle sticks or accidental contact with mucous

membranes such as eyes and mouth. Example: the bacteria that cause TB. “Biosafety Level 3”.

Carcinogen

Definition: Chemicals that cause malignant tumors, or other forms of cancer. Examples: some organic compounds (anthracene, aflatoxin), some solvents (chloroform, benzene), and some metals (hexavalent chromium).

Low: Occasional use of small amounts or dilute solutions. Example: Entomology lab using small quantities of dilute formaldehyde/water solutions to preserve specimens

Moderate: Routine use of material in pure form, such as acrylamide powder or diaminobenzidine (DAB), or use of several liters per week of carcinogenic solvents, such as phenol/chloroform extraction procedures.

High: Routine use of larger quantities of carcinogenic material where the risk of exposure is high because the material can be absorbed through skin or inhaled.

Flammable Liquid

Definition: Liquids that ignite easily and burn rapidly, and have a flash point less than 100F (37.7C).Examples: 95% ethanol, ether, hexane, acetone, and ethyl acetate

Low: Daily use of small quantities. Example: microbiology lab using alcohol for wiping bench tops.

Moderate: Routine use of highly volatile solvents in moderate quantities, away from ignition sources or the storage of up to 25 gallons. Examples: solvent extractions, refluxing or solvent distillation.

High: (1) Routine use of large quantities (2) any work with flammable liquids near an open flame or at elevated temperatures. Storage of over 25 gallons.

Chemical Storage

Definition: Storage of material that is not in use, excluding the hazard classes of flammable gases, flammable liquids, oxidizers, poison inhalation hazards, and water reactives, which are considered separately.

Low: Storage of small quantities of chemicals. Storage where the amount on hand would not cause a fire or serious health hazard if it came into accidental contact with water. No storage of poison inhalation hazards. Example: chemical storage in a teaching lab.

Moderate: Storage of hundreds of chemical containers. Minimal amounts of air or water reactive material, unstable or incompatible chemicals, or compressed or liquefied gases. Example: chemical inventory of a large research group.

High: Chemical stockrooms, large quantities of hazardous materials, including 55 gallon drums. Storage of significant amounts of air or water reactive material, unstable or incompatible chemicals, and/or compressed or liquefied gases.

Compressed Gas

Definition: Containers of compressed, liquefied or solidified gases which pose a risk of asphyxiation, and/or the risk of rapid freezing of tissue.
Examples: Compressed oxygen, liquid nitrogen, and dry ice (solid carbon dioxide). Flammable and highly toxic gases (poison inhalation hazards) are excluded from this category, and are considered separately.

Low: Use where a) the release rate of the gas can be controlled and b) the area is well ventilated and air is not re-circulated. Example: Gas cylinder with regulator used in a well ventilated laboratory where air is exhausted by fume hoods that vent to the roof.

Moderate: (1) Use of compressed gas with a low, well controlled flow rate in an area with poor ventilation or (2) the use of a container or gas supply system that could cause the sudden release of a large amount of gas.
High: Use of any compressed gases, including solidified or liquefied gases, in small un-ventilated space. Example: Use of liquid nitrogen or dry ice in a cold room or environmental chamber. (Note: This applies to rooms/chambers with circulating fans. They do not supply fresh air.)

Poison

Definition: Any substance which, in small quantities, can cause serious illness or death. Examples: arsenic, lead, and pesticides that block nerve transmission. For extensive information about poisons, consult Prudent Practices in the Laboratory published by the National Research Council.

Low: Use and storage of materials for which the lethal dose is more than an ounce (LD50 more than 500mg per kilogram) and that are not readily absorbed through the skin. Examples: methyl ethyl ketone, acetaldehyde, benzoic acid, methanol and hexane.

Moderate: Use and storage of materials for which the lethal dose is between an ounce and a teaspoon (LD50 between 50 to 500 mg per kilogram) OR less toxic compounds which can be absorbed through the skin. Examples: pyridine (skin absorbed), phenol (skin absorbed), butylamine, coomassie blue, guanidine hydrochloride and zinc chloride.

High: Use and storage of materials for which the lethal dose is less than a teaspoon (LD50 less than 50mg per kilogram).Examples: sodium cyanide, osmium tetroxide, sodium azide and heptafluorobutyric acid.

Corrosive

Definition: Any material that irritates or destructively attacks body tissues such as skin. Corrosive chemicals are typically acids such as hydrochloric acid and sulfuric acid, and bases such as sodium hydroxide and ammonium hydroxide.

Low: Routine use of dilute acid and base solutions, infrequent use of concentrated acids and bases. Example: undergraduate teaching laboratory.

Moderate: Routine use of a variety of strong acids and bases in concentrated form. Example: average chemistry laboratory.

High: Labs with large quantities (more than 10 gallons) of concentrated mineral acids or bases in frequent use, and benchtop use of acid baths with acid concentrations of greater than 6 molar.

Flammable Gas

Definition: Gases that ignite easily and burn rapidly. Common flammable gases are hydrogen, carbon monoxide, and acetylene.

Low: Use of small individual low-pressure containers or piped supply systems. Example: aerosol can of spray paint with a flammable gas as a propellant.

Moderate: Routine use of large high-pressure flammable gas cylinders. Use and storage of up to five large, high pressure cylinders of flammable gases.

High: Daily use of several large high pressure cylinders of flammable gas. Use and storage of 6 or more cylinders in a laboratory. Use or storage of propane cylinders greater than 1.5 pounds.

Explosive

Definition: A chemical compound, usually containing nitrogen, that detonates as a result of shock or heat.
Examples: trinitrotoluene (dynamite) and ammonium nitrate. Wetted explosives are Flammable Solids because they ignite easily at low temperatures. For extensive

information about the potential for a compound to detonate or react to form an explosive mixture, consult Bretherick's Handbook of Reactive Chemical Hazards.

Low: Use that involves amounts that can not produce a harmful explosion or use of the material in form that is not explosive. Example: histology lab using picric acid solution as a stain.

Moderate: Use that involves amounts that can produce a harmful explosion but use is limited to forms, such as aqueous solutions, that are not explosive. Example: Bouin's fixative.

High: Use of explosive compounds, in quantities that can produce a harmful explosion, in procedures that could produce a form that is explosive. Examples: refluxing diethyl ether (potentially concentrating peroxides), drying of picric acid.

Laser

Definition: Equipment that emits energy as a beam of electromagnetic radiation. Some laser beams are visible light that can be seen when they are present. Some lasers emit infra-red or ultraviolet radiation that is invisible. Medium and high intensity lasers can cause serious eye damage. High intensity lasers can also burn skin and can ignite combustible materials.

Low: Only class I, II, or IIIa lasers are in use. Beams from class I, II and IIIa lasers are always visible. There is no risk of injury unless an individual looks directly into the beam for an extended period of time. Example: HeNe laser pointers used in classrooms

Moderate: Class IIIb laser is in use. Momentary viewing of the direct beam, or a beam reflected from a mirror-like surface, may produce serious eye injury. Beams may not be visible.

High: Class IV laser is in use. Viewing of the direct beam and viewing of any type of reflection is likely to cause serious eye injury. Beams can cause skin burns. Beams can cause materials to burn and/or release hazardous materials to the air.

Oxidizer

Definition: Compounds that readily provide oxygen to support combustion. Oxidizers can initiate a fire as well as cause other materials to burn much more intensely than normal.
Examples: peroxides, chlorates, perchlorates, nitrates, and permanganates.

Low: Infrequent use of small quantities under conditions known to be controllable.
Example: teaching lab using 10% hydrogen peroxide in an experiment

Moderate: Routine use and storage of moderate quantities of oxidizers. Example: chromic acid bath used to clean glassware.

High: Routine use and storage of large quantities of strong oxidizers Examples: hot perchloric acid digestion, fertilizer storage areas.

Radiation

Definition: Energy emitted from radioactive materials (alpha, beta, gamma radiation) or emitted by radiation producing equipment (X-rays) that can cause
chemical changes in living cells that may result in immediate injury or an increased risk of cancer.

Present: Radioactive materials are being used in this laboratory.

You must have Radiation Safety approval to use radioactive materials in your laboratory before you can indicate this hazard on your hazard warning sign.

8.0 EXPOSURE EVALUATIONS

8.1 Suspected Exposures to Toxic Substances

There may be times when employees or supervisors suspect that an employee has been overexposed to a hazardous chemical that might have caused harm to the victim. If the circumstances suggest a reasonable suspicion of exposure, the victim is encouraged to undergo a medical consultation at Student Employee Health Service. This consultation and any related medical examination shall be provided at no cost with no loss of workday time attributed to the victim.

8.1.1 Criteria of Reasonable Suspicion of Exposure

The Department of Environmental Health and Safety investigates all employee-related incidents where there is or may be overexposure to a toxic substance. The following are examples of some events or circumstances that might reasonably constitute overexposure:

- Victim had direct skin or eye contact with a chemical substance.
- Odor was noticed, especially if person was working with any chemical which has a lower PEL than odor threshold.

- A hazardous chemical leaked, spilled, or was otherwise rapidly released in an uncontrolled manner.

- Manifestation of health hazard symptoms such as headache, rash, nausea, coughing, tearing, irritation or redness or eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgment, etc.

- Some or all symptoms disappear when person is taken away from chemical area and into fresh air.

- Symptoms reappear soon after person starts working with the same chemicals again.

- Complaints are received from more than one person in the same work area.

8.2 Exposure Evaluations

Once a complaint of possible hazardous chemical exposure has been received, a standard series of steps are taken to elucidate the situation. Unless circumstances suggest other or additional steps, the following actions taken by the CHO will constitute an exposure assessment:

- Interview the person initiating the complaint, and the victim if it is not the same person.

- List essential information about the circumstances of the complaint, including:

    - The chemical under suspicion.

    - All chemicals being used by others in the immediate area.

    - Other chemicals stored in that area.

    - Symptoms exhibited or claimed by victim.

    - Were control measures, such as fume hoods and personal protective equipment, used and used properly?

    - Were any air sampling or monitoring devices in place or available? If so, are the measurements obtained from these devices consistent with other information?

- Perform air sampling in the area for suspect chemicals.

- Determine whether the victim's symptoms compare to the symptoms described in the MSDS or other pertinent scientific literature.

- Review the adequacy of present control measures and safety procedures.

- Notify employee of the results of air sampling within 15 working days of receipt of the results.

9.0 MEDICAL CONSULTATION AND EXAMINATION

9.1 Provisions for Obtaining Medical Care

The details of medical consultations and examinations are determined by the physician. The purpose of a medical consultation is to determine whether a medical examination is warranted. When it is suspected or known that an employee was overexposed to a hazardous chemical or chemicals, the employee should obtain medical consultation from or under the direct supervision of a licensed physician at Student Employee Health Service (SEHS).

When warranted, employees also may also be referred by SEHS to receive a medical examination from or under the direct supervision of a licensed physician who is experienced in treating victims of chemical overexposure. The medical professional should also be knowledgeable about which tests or procedures are appropriate to determine if there has been an overexposure; these diagnostic techniques are called "differential diagnoses". Referral for medical examinations will be made by SEHS.

The following provisions apply to medical consultations and examinations:

- All employees who work with hazardous chemicals must be provided an opportunity to receive medical consultations and examination when:

    - The employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.

    - Monitoring, routine or otherwise, suggests that there could have been an exposure above the action level (or PEL if there is no action level) for a chemical for which a substance-specific standard has been established.

    - There is a spill, leak, or other uncontrolled release of a hazardous chemical.

- Provide the physician with:

- The identity of the hazardous chemical or chemicals to which the employee may have been exposed.
- The exposure conditions.
- The signs and symptoms of exposure the victim is experiencing, if any.

- Physicians will furnish to the Chemical Hygiene Office in written form:
  - Identification of diagnosis related to chemical exposure.
  - Recommendations for follow-up, if determined to be pertinent.
  - Conclusions concerning any other medical condition noted that could put the employee at increased risk.
  - A statement that the employee has been informed both of the results of the consultation or examination and of any medical condition that may require further examination or treatment.

- These written statements and records should not reveal specific findings that are not related to an occupational exposure.

9.2 Documentation and Notification

EHS will maintain records of all laboratory worker air monitoring, exposure evaluations, and medical consultations and examinations. Employees shall be notified of the results of any medical consultation or examination with regard to any medical condition that exists or might exist as a result of overexposure to a hazardous chemical.

10.0 RECORDS AND RECORDKEEPING

There are several repositories for records relevant to the OSHA Laboratory Standard. OSHA recordkeeping requirements are given in 29 CFR 1910.20. Included in those requirements is the maintenance of air monitoring results, exposure assessments, and medical consultations and examinations for at least 30 years. Records must be made accessible to employees or their representatives. All of the following are recordkeeping requirements of OSHA or IUPUI.

10.1 Departmental Recordkeeping

- Chemical Inventory.

- Material Safety Data Sheets.

10.2 Department of Environmental Health and Safety Recordkeeping

- Area and personal air monitoring results.
- Exposure assessments.
- Laboratory safety inspections.
- Material Safety Data Sheets - Master List.
- Health and safety complaints.
- Laboratory Safety Training attendance records.

10.3 Student Employee Health Services Record Keeping

- Medical consultations and examinations.
- Illness/injury information resulting from an exposure or accident on the job tha caused lost work time - Information received by SEHS and stored by the Risk Management Department of Indiana University - Bloomington.

11.0 Chemical Hygiene Plan Audit

The Chemical Hygiene Officer will conduct an audit of all phases of the Chemical Hygiene Plan annually. Changes to the CHP will be printed and distributed to all laboratories using or storing hazardous chemicals.

APPENDIX A

IUPUI POLICY ON EATING AND DRINKING IN LABORATORIES

Subject: Eating, Drinking, and Related Activities in Laboratories
Effective Date: February 1, 1997
Approved: Robert Martin, Vice Chancellor - Policy: 101

PURPOSE AND BACKGROUND:

Hazardous materials can be accidentally ingested when eating, drinking, smoking, gum chewing, or related activities are permitted within workplace and teaching laboratories. To eliminate this potential route of exposure, OSHA has developed guidelines which prohibit these activities in areas where laboratory chemicals are present. In addition, OSHA recommends hand washing before these activities are conducted.

SCOPE:

This policy applies to all staff, faculty, students and University guests entering University laboratories.

POLICY:

Eating, drinking, smoking, gum chewing, the application of cosmetics and the storage of food and beverages are not permitted in laboratories containing hazardous materials. These activities may take place in a separate area which is a room with floor to ceiling walls and a door separating the area from the laboratory space in which hazardous materials are used, stored, or transported.

PROCEDURE:

Each school, department, or section is responsible for identifying laboratories where eating, drinking, smoking, and related activities are prohibited. Notifying students and staff of appropriate places for eating, drinking, and related activities is advisable.
When planning renovations or new spaces, consideration should be given to providing appropriate areas for eating and drinking.

APPENDIX B

IUPUI EYE PROTECTION IN LABORATORIES POLICY

Subject: Eye Protection in Laboratories
Effective Date: February 1, 1997
Approved: Robert Martin, Vice Chancellor - Policy: 102

SCOPE:

These requirements apply to all staff, faculty, students and University guests entering University laboratories.

POLICY:

Eye protection shall be used according to the following laboratory classification.

LABORATORY CLASSIFICATION SYSTEM

CLASS 1 - EYE PROTECTION NOT REQUIRED
Laboratories that do not use chemicals, biologicals or physically hazardous materials.
Example: computer laboratory
CLASS 2 - EYE PROTECTION REQUIRED WHEN HAZARD EXISTS
Laboratories that use chemicals, biologicals or physically hazardous materials on an occasional basis.
Example: laser laboratory
CLASS 3 - EYE PROTECTION REQUIRED AT ALL TIMES
Laboratories that routinely use chemicals, biologicals, or machinery.
Example: most chemical laboratories

PROCEDURES:

Each department shall determine the hazard class of each laboratory. These requirements shall be posted outside each laboratory door. If a procedure creates a greater hazard than the laboratory classification would indicate, eye and face protection appropriate for the hazard shall be worn. Protective devices will be provided to employees at no charge. Each department will be responsible for enforcement of this approved policy. If the recommended policy does not apply

to a particular situation, departments must provide an alternative policy for approval by the Laboratory Safety Committee.

Guidance for the selection of eye and face protection is given in the "American National Standard for Occupational and Educational Eye and Face Protection" (ANSI Z87.1). Environmental Health and Safety will assist in determining the appropriate eye and face protection for specific laboratory hazards and will provide vendor information for securing equipment.

APPENDIX C

IUPUI WASTE ANESTHETIC GAS POLICY

Subject: Anesthetic Gas Safety
Effective Date: July 22, 2005
Approved: IUPUI Laboratory Safety Committee

I. Purpose

The Environmental Health and Safety (EHS) Department has developed this policy to protect employees at Indiana University Purdue University at Indianapolis (IUPUI) who have an occupational exposure to anesthetic gases. Inhaled anesthetics include two classes of chemicals: nitrous oxide and halogenated agents. Halogenated anesthetic gases include halothane, isoflurane, sevoflurane, desflurane, enflurane, and methoxyflurane (used infrequently).

The policy set forth is intended to ensure compliance with federal, state, and local requirements. Presently, the Occupational Safety and Health Administration (OSHA) has not adapted a regulation regarding waste anesthetic gases (WAG's). The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have recommended exposure limits for WAG's

II. Scope

This policy applies to all employees who work with or supervise work involving anesthetic gases at the IUPUI campus. Anesthetic gases are used in laboratories throughout campus during animal surgical procedures and in the dental school during surgical procedures.

III. Responsibilities

EHS is responsible for:

1. The development, implementation, and oversight of the program.
2. Area and personal air monitoring to determine exposure.
3. Ensuring compliance with all federal, state, and local regulations.

The Departments are responsible for:

1. Ensuring that all personnel have been trained prior to anesthetic gas use.
2. Following all safety guidelines for anesthetic gas use.
3. Anesthetic gas equipment maintenance.
4. Reporting any liquid agent spills or releases to EHS.
5. Compliance with IUPUI's Hazard Communication Program.
6. Reporting results of all monitoring to employees.
7. Ensuring completion of an incident report for any health or safety related incidents and forwarding the report to Occupational Health Services and EHS.

Employees are responsible for:
1. Completing the anesthetic gas training course.
2. Following all safety guidelines when working with anesthetic gases.
3. Inspecting all equipment prior to and after each use.
4. Ensuring the scavenge system is used with all anesthetic gas machines.
5. Reporting any problems with equipment to department management.
6. Reporting any liquid agent spills or releases to department management and EHS.
7. Following IUPUI's Hazard Communication Program.
8. Reporting any health or safety concerns to department management and completing an incident report.

IV. Regulatory Limits

Presently, the Occupational Safety and Health Administration (OSHA) has not created or adapted a regulation regarding WAG's. The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have recommended exposure limits for WAG's. The following table summarizes the recommended exposure limits.

Table 1

Anesthetic Gas	OSHA PEL (ppm) [1]	NIOSH REL (ppm)[2]	ACGIH TLV-TWA (ppm)[3]
Nitrous Oxide (N_20)	None	254	50
Isoflurane	None	Ceiling [5]	None
Halothane	None	Ceiling [5]	50
Desflurane	None	Ceiling [5]	None
Sevoflurane	None	Ceiling [5]	None
Enflurane	None	Ceiling [5]	75

V. Exposure Monitoring

EHS can perform air monitoring to determine the anesthetic gas concentrations in the

air. The two types of monitoring performed are personal and area. Personal monitoring is conducted at the employee's breathing zone to determine WAG exposure for the employee. The monitoring is performed using a passive dosimeter which collects gas on a media and is then analyzed by a laboratory. Area monitoring is conducted in the work area to give WAG concentrations in work areas. A portable infrared spectrophotometer, or direct read instrument, is used to collect real time samples. EHS can also perform leak testing on the equipment to determine if gas is escaping from various locations in the machine. A portable infrared spectrophotometer is used to detect leakage.

VI. Training

All employees who work with or supervise work with anesthetic gases shall complete on-line training via EHS's website prior to using any anesthetic gas.

The training shall consist of the following: regulatory limits, health effects of nitrous oxide and halogenated agents, sources of exposure, scavenge systems, anesthetic gas equipment inspections, engineering controls, work practices, administrative controls, liquid agent spills, air monitoring, medical surveillance, and hazard communication. The training shall be conducted upon initial assignment and whenever there is a change in process or procedure.

VII. Information

For additional information regarding IUPUI's anesthetic gas policy, please refer to EHS's Anesthetic Gas Training Program at www.ehs.iupui.edu or contact EHS at 274-2005.

APPENDIX D

OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

THE OSHA LABORATORY STANDARD (29 CFR 1910.1450)

OSHA LABORATORY STANDARD:

1910.1450(a)
Scope and application.
1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.
1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:
1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.
1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.
1910.1450(a)(3)
This section shall not apply to:
..1910.1450(a)(3)(i)

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.
1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and
1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.
1910.1450(b)
Definitions --

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

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

Carcinogen (***see select carcinogen***).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

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

Compressed gas means:

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

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

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

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

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.

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 protection 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 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 12 percent by volume, regardless of the lower limit.

(iii) ***Liquid, flammable*** means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. 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 deg. F (37.8 deg. 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 Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. 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.

Hazardous chemical 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 systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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 tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a

lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is 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.

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

1910.1450(c)

Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

..1910.1450(d)

1910.1450(d)

Employee exposure determination --

1910.1450(d)(1)

Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2)

Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)

Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)

Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)

Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)

Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)

Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)

Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)

The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)

The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)

Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)

Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910.1450(e)(3)(iii)

A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

..1910.1450(e)(3)(iv)

1910.1450(e)(3)(iv)

Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910.1450(e)(3)(v)

The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910.1450(e)(3)(vi)

Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910.1450(e)(3)(vii)

Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

1910.1450(e)(3)(viii)

Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)

Establishment of a designated area;

1910.1450(e)(3)(viii)(B)

Use of containment devices such as fume hoods or glove boxes;
1910.1450(e)(3)(viii)(C)
Procedures for safe removal of contaminated waste; and
1910.1450(e)(3)(viii)(D)
Decontamination procedures.
1910.1450(e)(4)
The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.
1910.1450(f)
Employee information and training.
1910.1450(f)(1)
The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.
1910.1450(f)(2)
Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.
1910.1450(f)(3)
Information. Employees shall be informed of:
1910.1450(f)(3)(i)
The contents of this standard and its appendices which shall be made available to employees;
1910.1450(f)(3)(ii)
the location and availability of the employer's Chemical Hygiene Plan;
..1910.1450(f)(3)(iii)

1910.1450(f)(3)(iii)
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
1910.1450(f)(3)(iv)
Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
1910.1450(f)(3)(v)
The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.
1910.1450(f)(4)
Training.
1910.1450(f)(4)(i)
Employee training shall include:
1910.1450(f)(4)(i)(A)
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1450(f)(4)(i)(B)
The physical and health hazards of chemicals in the work area; and
1910.1450(f)(4)(i)(C)
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.
1910.1450(f)(4)(ii)
The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.
1910.1450(g)
Medical consultation and medical examinations.
1910.1450(g)(1)
The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:
1910.1450(g)(1)(i)
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
1910.1450(g)(1)(ii)
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
1910.1450(g)(1)(iii)
Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.
..1910.1450(g)(2)

1910.1450(g)(2)
All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.
1910.1450(g)(3)
Information provided to the physician. The employer shall provide the following information to the physician:
1910.1450(g)(3)(i)
The identity of the hazardous chemical(s) to which the employee may have been exposed;
1910.1450(g)(3)(ii)
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)
A description of the signs and symptoms of exposure that the employee is experiencing, if any.
1910.1450(g)(4)
Physician's written opinion.
1910.1450(g)(4)(i)
For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:
1910.1450(g)(4)(i)(A)
Any recommendation for further medical follow-up;
1910.1450(g)(4)(i)(B)
The results of the medical examination and any associated tests;
1910.1450(g)(4)(i)(C)
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and
1910.1450(g)(4)(i)(D)
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.
1910.1450(g)(4)(ii)
The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.
1910.1450(h)
Hazard identification.
1910.1450(h)(1)
With respect to labels and material safety data sheets:
1910.1450(h)(1)(i)
Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
1910.1450(h)(1)(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.
1910.1450(h)(2)
The following provisions shall apply to chemical substances developed in the laboratory:
..1910.1450(h)(2)(i)

1910.1450(h)(2)(i)
If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.
1910.1450(h)(2)(ii)
If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii)
If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.
1910.1450(i)
Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.
1910.1450(j)
Recordkeeping.
1910.1450(j)(1)
The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.
1910.1450(j)(2)
The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.
1910.1450(k)
Dates --
1910.1450(k)(1)
Effective date. This section shall become effective May 1, 1990.
1910.1450(k)(2)
Start-up dates.
1910.1450(k)(2)(i)
Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.
1910.1450(k)(2)(ii)
Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.
1910.1450(l)
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.

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996]

APPENDIX E

LIMITS FOR AIR CONTAMINANTS

29 CFR 1910.1000(f)(4)
TABLES Z-1, Z-2, AND Z-3

TABLE Z-1. - LIMITS FOR AIR CONTAMINANTSTABLE Z-1. - LIMITS FOR AIR CONTAMINANTS

Substance	CAS No. (c)	ppm (a)(1)	mg/m(3) (b)(1)	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorene; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloroethylene.				
Acetylene tetrabromide.	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1	.....	0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2	.....	0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide.	2179-59-1	2	12	
alpha-Alumina	1344-28-1			
Total dust		.....	15	
Respirable fraction.		.....	5	
Aluminum Metal (as Al).	7429-90-5			
Total dust		.....	15	
Respirable fraction.		.....	5	
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol; see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust		.....	15	
Respirable fraction.		.....	5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o-,p-isomers)	29191-52-4	.....	0.5	X
Antimony and compounds (as Sb)	7440-36-0	.....	0.5	
ANTU (alpha Naphthylthiourea)	86-88-4	.....	0.3	
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2			
Arsenic, organic				

compounds (as As)....	7440-38-2	.....	0.5	
Arsine.....	7784-42-1	0.05	0.2	
Asbestos;				
see 1910.1001.....	(4)			
Azinphos-methyl.....	86-50-0	.....	0.2	X
Barium, soluble				
compounds (as Ba)....	7440-39-3	.....	0.5	
Barium sulfate.....	7727-43-7			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Benomyl.....	17804-35-2			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Benzene; See 1910.1028.	71-43-2			
See Table Z-2 for				
the limits				
applicable in the				
operations or				
sectors excluded				
in 1910.1028(d)				
Benzidine;				
See 1910.1010.....	92-87-5			
p-Benzoquinone;				
see Quinone.				
Benzo(a)pyrene; see				
Coal tar pitch				
volatiles.....				
Benzoyl peroxide.....	94-36-0	.....	5	
Benzyl chloride.....	100-44-7	1	5	
Beryllium and				
beryllium compounds				
(as Be).....	7440-41-7		(2)	
Biphenyl; see Diphenyl.				
Bismuth telluride,				
Undoped.....	1304-82-1			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Boron oxide.....	1303-86-2			
Total dust.....		.....	15	
Boron trifluoride.....	7637-07-2	(C)1	(C)3	
Bromine.....	7726-95-6	0.1	0.7	
Bromoform.....	75-25-2	0.5	5	X
Butadiene				
(1,3-Butadiene); See				
29 CFR 1910.1051;	106-99-0	1 ppm/5		
29 CFR 1910.19(1)....		ppm STEL		
Butanethiol;				
see Butyl mercaptan.				
2-Butanone				
(Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol.....	111-76-2	50	240	X
n-Butyl-acetate.....	123-86-4	150	710	
sec-Butyl acetate.....	105-46-4	200	950	
tert-Butyl-acetate.....	540-88-5	200	950	
n-Butyl alcohol.....	71-36-3	100	300	
sec-Butyl alcohol.....	78-92-2	150	450	
tert-Butyl alcohol.....	75-65-0	100	300	

Butylamine	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO(3))	1189-85-1	.....	(C)0.1	X
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270	
Butyl mercaptan	109-79-5	10	35	
p-tert-Butyltoluene	98-51-1	10	60	
Cadmium (as Cd); see 1910.1027	7440-43-9			
Calcium Carbonate	1317-65-3			
Total dust		.....	15	
Respirable fraction		.....	5	
Calcium hydroxide	1305-62-0			
Total dust		.....	15	
Respirable fraction		.....	5	
Calcium oxide	1305-78-8	.....	5	
Calcium silicate	1344-95-2			
Total dust		.....	15	
Respirable fraction		.....	5	
Calcium sulfate	7778-18-9			
Total dust		.....	15	
Respirable fraction		.....	5	
Camphor, synthetic	76-22-2	.....	2	
Carbaryl (Sevin)	63-25-2	.....	5	
Carbon black	1333-86-4	.....	3.5	
Carbon dioxide	124-38-9	5000	9000	
Carbon disulfide	75-15-0		(2)	
Carbon monoxide	630-08-0	50	55	
Carbon tetrachloride	56-23-5		(2)	
Cellulose	9004-34-6			
Total dust		.....	15	
Respirable fraction		.....	5	
Chlordane	57-74-9	.....	0.5	X
Chlorinated camphene	8001-35-2	.....	0.5	X
Chlorinated diphenyl oxide	55720-99-5	.....	0.5	
Chlorine	7782-50-5	(C)1	(C)3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	
Chlorobenzene	108-90-7	75	350	
o-Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; See beta-Chloroprene.				
Chlorodiphenyl (42% Chlorine)(PCB)	53469-21-9	.....	1	X
Chlorodiphenyl (54% Chlorine)(PCB)	11097-69-1	.....	0.5	X
1-Chloro-2, 3-epoxypropane; See Epichlorohydrin.				
2-Chloroethanol; See Ethylene chlorohydrin				

Chloroethylene; See Vinyl chloride.				
Chloroform (Trichloromethane)...	67-66-3	(C)50	(C)240	
bis(Chloromethyl) ether; see 1910.1008.	542-88-1			
Chloromethyl methyl ether; see 1910.1006.	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin.....	76-06-2	0.1	0.7	
beta-Chloroprene.....	126-99-8	25	90	X
2-Chloro-6 (trichloromethyl) pyridine.....	1929-82-4			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Chromic acid and chromates (as CrO(3))	(4)		(2)	
Chromium (II) compounds (as Cr).....	7440-47-3	.....	0.5	
Chromium (III) compounds (as Cr)....	7440-47-3	.....	0.5	
Chromium metal and insol. salts (as Cr).	7440-47-3	.....	1	
Chrysene; see Coal tar pitch volatiles.....				
Clopidol.....	2971-90-6			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Coal dust (less than 5% SiO(2)), respirable fraction..			(3)	
Coal dust (greater than or equal to 5% SiO(2)), respirable fraction.....			(3)	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene.....	65966-93-2	.....	0.2	
Cobalt metal, dust, and fume (as Co).....	7440-48-4	.....	0.1	
Coke oven emissions; see 1910.1029.....				
Copper.....	7440-50-8			
Fume (as Cu).....		.....	0.1	
Dusts and mists (as Cu).....		.....	1	
Cotton dust (e), see 1910.1043.....		.....	1	
Crag herbicide (Sesone)	136-78-7			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Cresol, all isomers....	1319-77-3	5	22	X

Crotonaldehyde	123-73-9	2	6	
	4170-30-3			
Cumene	98-82-8	50	245	X
Cyanides (as CN)	(4)	.....	5	X
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclopentadiene	542-92-7	75	200	
2,4-D (Dichlorophenoxyacetic acid)	94-75-7	.....	10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox)	8065-48-3	.....	0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenediamine				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (DBCP); see 1910.1044	96-12-8			
1,2-Dibromoethane; see Ethylene dibromide				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2	.....	5	
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5	.....	0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3	.....	1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichloride				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	
1,2-Dichloropropane; see Propylene dichloride				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7	.....	1	X
Dicyclopentadienyl iron	102-54-5			
Total dust		.....	15	
Respirable fraction		.....	5	
Dieldrin	60-57-1	.....	0.25	X

Diethylamine.....	109-89-7	25	75	
2-Diethylaminoethanol..	100-37-8	10	50	X
Diethyl ether; see Ethyl ether.....				
Difluorodibromomethane.	75-61-6	100	860	
Diglycidyl ether (DGE).	2238-07-5	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone.....				
Diisobutyl ketone.....	108-83-8	50	290	
Diisopropylamine.....	108-18-9	5	20	X
4-Dimethylaminoazo-benzene; see 1910.1015.....	60-11-7			
Dimethoxymethane; see Methylal.....				
Dimethyl acetamide.....	127-19-5	10	35	X
Dimethylamine.....	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine.....				
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene.....				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate.....	300-76-5	.....	3	
Dimethylformamide.....	68-12-2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone....				
1,1-Dimethylhydrazine..	57-14-7	0.5	1	X
Dimethylphthalate.....	131-11-3	.....	5	
Dimethyl sulfate.....	77-78-1	1	5	X
Dinitrobenzene				
(all isomers).....			1	X
(ortho).....	528-29-0			
(meta).....	99-65-0			
(para).....	100-25-4			
Dinitro-o-cresol.....	534-52-1	.....	0.2	X
Dinitrotoluene.....	25321-14-6	.....	1.5	X
Dioxane (Diethylene dioxide).	123-91-1	100	360	X
Diphenyl (Biphenyl)....	92-52-4	0.2	1	
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate.....				
Dipropylene glycol methyl ether.....	34590-94-8	100	600	X
Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate).....	117-81-7	.....	5	
Emery.....	12415-34-8			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Endrin.....	72-20-8	.....	0.1	X
Epichlorohydrin.....	106-89-8	5	19	X

EPN	2104-64-5	.....	0.5	X
1,2-Epoxypropane; see Propylene oxide				
2,3-Epoxy-1-propanol; see Glycidol				
Ethanethiol; see Ethyl mercaptan				
Ethanolamine	141-43-5	3	6	
2-Ethoxyethanol (Cellosolve)	110-80-5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	(C)10	(C)25	
Ethyl silicate	78-10-4	100	850	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	
Ethylene dibromide	106-93-4		(2)	
Ethylene dichloride (1,2-Dichloroethane)	107-06-2		(2)	
Ethylene glycol dinitrate	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate				
Ethyleneimine; see 1910.1012	151-56-4			
Ethylene oxide; see 1910.1047	75-21-8			
Ethylidene chloride; see 1,1-Dichlorethane				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam	14484-64-1			
Total dust		.....	15	
Ferrovanadium dust	12604-58-9	.....	1	
Fluorides (as F)	(4)	.....	2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichloro-fluoromethane)	75-69-4	1000	5600	
Formaldehyde; see 1910.1048	50-00-0			
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X

Furfuryl alcohol	98-00-0	50	200	
Grain dust (oat, wheat barley)	.....	.....	10	
Glycerin (mist)	56-81-5			
Total dust		.....	15	
Respirable fraction		.....	5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				
Graphite, natural respirable dust	7782-42-5		(3)	
Graphite, synthetic				
Total dust		.....	15	
Respirable Fraction		.....	5	
Guthion; see Azinphos methyl				
Gypsum	13397-24-5			
Total dust		.....	15	
Respirable fraction		.....	5	
Hafnium	7440-58-6	.....	0.5	
Heptachlor	76-44-8	.....	0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1	.....	0.2	X
n-Hexane	110-54-3	500	1800	
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3		(2)	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4		(2)	
Hydroquinone	123-31-9	.....	2	
Iodine	7553-56-2	(C)0.1	(C)1	
Iron oxide fume	1309-37-1	.....	10	
Isomyl acetate	123-92-2	100	525	
Isomyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin	1332-58-7			

Total dust		.....	15	
Respirable fraction		.....	5	
Ketene	463-51-4	0.5	0.9	
Lead inorganic (as Pb); see 1910.1025	7439-92-1			
Limestone	1317-65-3			
Total dust		.....	15	
Respirable fraction		.....	5	
Lindane	58-89-9	.....	0.5	X
Lithium hydride	7580-67-8	.....	0.025	
L.P.G. (Liquified petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust		.....	15	
Respirable fraction		.....	5	
Magnesium oxide fume	1309-48-4			
Total Particulate		.....	15	
Malathion	121-75-5			
Total dust		.....	15	X
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5	.....	(C)5	
Manganese fume (as Mn)	7439-96-5	.....	(C)5	
Marble	1317-65-3			
Total dust		.....	15	
Respirable fraction		.....	5	
Mercury (aryl and inorganic)(as Hg)	7439-97-6		(2)	
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		(2)	
Mercury (vapor) (as Hg)	7439-97-6		(2)	
Mesityl oxide	141-79-7	25	100	
Methanethiol; see Methyl mercaptan.				
Methoxychlor	72-43-5			
Total dust		.....	15	
2-Methoxyethanol; (Methyl cellosolve)	109-86-4	25	80	X
2-Methoxyethyl acetate (Methyl cellosolve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl Isobutyl carbinol				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X

Methyl butyl ketone; see 2-Hexanone				
Methyl cellosolve; see 2-Methoxyethanol				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate				
Methyl chloride	74-87-3		(2)	
Methyl chloroform (1,1,1-Trichloro-ethane)	71-55-6	350	1900	
Methylcyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
o-Methylcyclohexanone	583-60-8	100	460	X
Methylene chloride	75-09-2		(2)	
Methyl ethyl ketone (MEK); see 2-Butanone				
Methyl formate	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydrazine)	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3	100	475	
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl mercaptan	74-93-1	(C)10	(C)20	
Methyl methacrylate	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone				
alpha-Methyl styrene	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2	
Mica; see Silicates				
Molybdenum (as Mo)	7439-98-7			
Soluble compounds		.....	5	
Insoluble Compounds Total dust		.....	15	
Monomethyl aniline	100-61-8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine.				
Morpholine	110-91-8	20	70	X
Naphtha (Coal tar)	8030-30-6	100	400	
Naphthalene	91-20-3	10	50	
alpha-Naphthylamine; see 1910.1004	134-32-7			
beta-Naphthylamine; see 1910.1009	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0	.....	1	
Nickel, soluble compounds (as Ni)	7440-02-0	.....	1	

Nicotine	54-11-5	.....	0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5	.....	1	X
4-Nitrodiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
N-Nitrosodimethylamine; see 1910.1016				
Nitrotoluene (all isomers)		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer	99-99-0			
Nitrotrichloromethane; see Chloropicrin				
Octachloronaphthalene	2234-13-1	.....	0.1	X
Octane	111-65-9	500	2350	
Oil mist, mineral	8012-95-1	.....	5	
Osmium tetroxide (as Os)	20816-12-0	.....	0.002	
Oxalic acid	144-62-7	.....	1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7 1910-42-5 2074-50-2	.....	0.5	X
Parathion	56-38-2	.....	0.1	X
Particulates not otherwise regulated (PNOR)(f)				
Total dust		.....	15	
Respirable fraction		.....	5	
PCB; see Chlorodiphenyl (42% and 54% chlorine)				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8	.....	0.5	X
Pentachlorophenol	87-86-5	.....	0.5	X
Pentaerythritol	115-77-5			
Total dust		.....	15	
Respirable fraction		.....	5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (Tetrachloroethylene)	127-18-4		(2)	
Perchloromethyl				

mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Petroleum distillates (Naphtha)(Rubber Solvent)		500	2000	
Phenol	108-95-2	5	19	X
p-Phenylene diamine	106-50-3	.....	0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7	.....	0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2	.....	1	
Phosphorus (yellow)	7723-14-0	.....	0.1	
Phosphorus pentachloride	10026-13-8	.....	1	
Phosphorus pentasulfide	1314-80-3	.....	1	
Phosphorus trichloride	7719-12-2	0.5	3	
Phthalic anhydride	85-44-9	2	12	
Picloram	1918-02-1			
Total dust		.....	15	
Respirable fraction		.....	5	
Picric acid	88-89-1	.....	0.1	X
Pindone (2-Pivalyl-1, 3-indandione)	83-26-1	.....	0.1	
Plaster of paris	26499-65-0			
Total dust		.....	15	
Respirable fraction		.....	5	
Platinum (as Pt)	7440-06-4			
Metal		.....	.....	
Soluble Salts		.....	0.002	
Portland cement	65997-15-1			
Total dust		.....	15	
Respirable fraction		.....	5	
Propane	74-98-6	1000	1800	
beta-Propriolactone; see 1910.1013	57-57-8			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7	.....	5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX: see Cyclonite				
Rhodium (as Rh), metal				

fume and insoluble compounds.....	7440-16-6	.....	0.1
Rhodium (as Rh), soluble compounds....	7440-16-6	.....	0.001
Ronnel.....	299-84-3	.....	15
Rotenone.....	83-79-4	.....	5
Rouge.....			
Total dust.....		.....	15
Respirable fraction..		.....	5
Selenium compounds (as Se).....	7782-49-2	.....	0.2
Selenium hexafluoride (as Se).....	7783-79-1	0.05	0.4
Silica, amorphous, precipitated and gel.	112926-00-8		(3)
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2		(3)
Silica, crystalline cristobalite, respirable dust.....	14464-46-1		(3)
Silica, crystalline quartz, respirable dust.....	14808-60-7		(3)
Silica, crystalline tripoli (as quartz), respirable dust.....	1317-95-9		(3)
Silica, crystalline tridymite, respirable dust.....	15468-32-3		(3)
Silica, fused, respirable dust.....	60676-86-0		(3)
Silicates (less than 1% crystalline silica)			
Mica (respirable dust).....	12001-26-2		(3)
Soapstone, total dust	.....		(3)
Soapstone, respirable dust.....	.....		(3)
Talc (containing asbestos): use asbestos limit: see 29 CFR 1910.1001.....			(3)
Talc (containing no asbestos), respirable dust.....	14807-96-6		(3)
Tremolite, asbestiform; see 1910.1001.....			
Silicon.....	7440-21-3		
Total dust.....		.....	15
Respirable fraction..		.....	5
Silicon carbide.....	409-21-2		
Total dust.....		.....	15
Respirable fraction..		.....	5
Silver, metal and			

soluble compounds (as Ag)	7440-22-4	.....	0.01	
Soapstone; see Silicates				
Sodium fluoroacetate	62-74-8	.....	0.05	X
Sodium hydroxide	1310-73-2	.....	2	
Starch	9005-25-8			
Total dust		.....	15	
Respirable fraction		.....	5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9	.....	0.15	
Styrene	100-42-5		(2)	
Sucrose	57-50-1			
Total dust		.....	15	
Respirable fraction		.....	5	
Sulfur dioxide	7446-09-5	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9	.....	1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton				
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93-76-5	.....	10	
Talc; see Silicates				
Tantalum, metal and oxide dust	7440-25-7	.....	5	
TEDP (Sulfotep)	3689-24-5	.....	0.2	X
Tellurium and compounds (as Te)	13494-80-9	.....	0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temephos	3383-96-8			
Total dust		.....	15	
Respirable fraction		.....	5	
TEPP (Tetraethyl pyrophosphaate)	107-49-3	.....	0.05	X
Terphenylis	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2, 2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1, 2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachoroethylene; see Perchloroethylene				
Tetrachloromethane; see Carbon tetrachloride.				
Tetrachloronaphthalene	1335-88-2	.....	2	X
Tetraethyl lead (as Pb)	78-00-2	.....	0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead, (as Pb)	75-74-1	.....	0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X

Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitro-phenylmethyl-nitramine)	479-45-8	.....	1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0	.....	0.1	X
4,4'-Thiobis(6-tert, Butyl-m-cresol)	96-69-5			
Total dust		.....	15	
Respirable fraction		.....	5	
Thiram	137-26-8	.....	5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5	.....	2	
Tin, organic compounds (as Sn)	7440-31-5	.....	0.1	
Titanium dioxide	13463-67-7			
Total dust		.....	15	
Toluene	108-88-3		(2)	
Toluene-2, 4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene				
Tremolite; see Silicates				
Tributyl phosphate	126-73-8	.....	5	
1,1,1-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6		(2)	
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9	.....	5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2, 2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
2,4,6-Trinitrophenol; see Picric acid				
2,4,6-Trinitrophenyl-methyl nitramine; see Tetryl				
2,4,6-Trinitrotoluene (TNT)	118-96-7	.....	1.5	X
Triorthocresyl phosphate	78-30-8	.....	0.1	
Triphenyl phosphate	115-86-6	.....	3	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds		.....	0.05	
Insoluble compounds		.....	0.25	
Vanadium	1314-62-1			
Respirable dust (as V(2)O(5))		.....	(C)0.5	
Fume (as V(2)O(5))		.....	(C)0.1	

Vegetable oil mist.....				
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Vinyl benzene;				
see Styrene.....				
Vinyl chloride;				
see 1910.1017.....	75-01-4			
Vinyl cyanide;				
see Acrylonitrile				
Vinyl toluene.....	25013-15-4	100	480	
Warfarin.....	81-81-2	.....	0.1	
Xylenes				
(o-, m-, p-isomers)..	1330-20-7	100	435	
Xylidine.....	1300-73-8	5	25	X
Yttrium.....	7440-65-5	.....	1	
Zinc chloride fume.....	7646-85-7	.....	1	
Zinc oxide fume.....	1314-13-2	.....	5	
Zinc oxide.....	1314-13-2			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Zinc stearate.....	557-05-1			
Total dust.....		.....	15	
Respirable fraction..		.....	5	
Zirconium compounds				
(as Zr).....	7440-67-7	.....	5	

Footnote (1) The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.

Footnote (a) Parts of vapor or gas per million parts of contaminated air by volume at 25 degrees C and 760 torr.

Footnote (b) Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

Footnote (c) The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given - not CAS numbers for the individual compounds.

Footnote (d) The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.

Footnote (e) This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.

Footnote (f) All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.

Footnote (2) See Table Z-2.
Footnote (3) See Table Z-3
Footnote (4) Varies with compound.

[54 FR 36767, Sept. 5, 1989; 54 FR 41244, Oct. 6, 1989; 55 FR 3724, Feb. 5, 1990; 55 FR 12819, Apr 6, 1990; 55 FR 19259, May 9, 1990; 55 FR 46950, Nov. 8, 1990; 57 FR 29204, July 1, 1992; 57 FR 42388, Sept. 14, 1992; 58 FR 35340, June 30, 1993; 61 FR 56746, Nov. 4, 1996; 62 FR 42018, August 4, 1997]

TABLE Z-2

Substance	8-hour time weighted average	Acceptable ceiling concentration	Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift	
			Concentration	Maximum duration
Benzene[a] (Z37.40-1969)	10 ppm	25 ppm	50 ppm	10 minutes.
Beryllium and beryllium compounds (Z37.29-1970)	2 ug/m(3)	5 ug/m(3)	25 ug/m(3)	30 minutes.
Cadmium fume[b] (Z37.5-1970)	0.1 mg/m(3)	0.3 mg/m(3)	.....	
Cadmium dust[b] (Z37.5-1970)	0.2 mg/m(3)	0.6 mg/m(3)		
Carbon disulfide (Z37.3-1968)	20 ppm	30 ppm	100 ppm	30 minutes.
Carbon tetrachloride (Z37.17-1967)	10 ppm	25 ppm	200 ppm	5 min. in any 3 hrs.
Chromic acid and chromates (Z37-7-1971)	.....	1 mg/10 m(3)		
Ethylene dibromide (Z37.31-1970)	20 ppm	30 ppm	50 ppm	5 minutes.
Ethylene dichloride (Z37.21-1969)	50 ppm	100 ppm	200 ppm	5 min. in any 3 hrs.
Fluoride as dust (Z37.28-1969)	2.5 mg/m(3)	.....	.....	
Formaldehyde: see 1910.1048	.....	.....	.....	
Hydrogen fluoride (Z37.28-1969)	3 ppm	.....	.....	
Hydrogen sulfide (Z37.2-1966)	.....	20 ppm	50 ppm	10 mins. once only if no other meas. exp. occurs.
Mercury (Z37.8-1971)	.....	1 mg/10m(3)	.....	
Methyl chloride (Z37.18-1969)	100 ppm	200 ppm	300 ppm	5 mins. in any 3 hrs.
Methylene Chloride: see 1910.1052				
Organo (alkyl) mercury (Z37.30-1969)	0.01mg/m(3)	0.04 mg/m(3)	.....	
Styrene (Z37.15-1969)	100 ppm	200 ppm	600 ppm	5 mins. in any 3 hrs.
Tetrachloroethylene	100 ppm	200 ppm	300 ppm	5 mins. in any 3 hrs.
Toluene (Z37.12-1967)	200 ppm	300 ppm	500 ppm	10 minutes
Trichloroethylene (Z37.19-1967)	100 ppm	200 ppm	300 ppm	5 mins. in any 2 hrs.

Footnote[a] This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028.

Footnote[b] This standard applies to any operations or sectors for which the Cadmium standard, 1910.1027, is stayed or otherwise not in effect.

TABLE Z-3 Mineral Dusts

Substance	mppcf [a]	mg/m³
Silica: Crystalline		
Quartz (Respirable)	$\frac{250}{\%SiO_2+5}$ [b]	$\frac{10\ mg/m^3}{\%SiO_2+2}$ [e]
Quartz (Total Dust)	. . . . .	$\frac{30\ mg/m^3}{\%SiO_2+2}$
▪ Cristobalite: Use ½ the value calculated from the count or mass formulae for quartz.		
▪ Tridymite: Use ½ the value calculated from the formulae for quartz.		
Amorphous, including natural diatomaceous earth	20	$\frac{80\ mg/m^3}{\%SiO_2}$
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc (not containing asbestos)	20[c]	
Talc (containing asbestos) Use asbestos limit		
Tremolite, asbestiform (see 29 CFR 1910.1001)		
Portland cement	50	
Graphite (Natural)	15	
Coal Dust:		
Respirable fraction less than 5% SiO_2	. . . . .	2.4 mg/m³ [e]
Respirable fraction greater than 5% SiO_2	. . . . .	$\frac{10\ mg/m^3}{\%SiO_2+2}$ [e]
Inert or Nuisance Dust:[d]		
Respirable fraction	15	5 mg/m³
Total dust	50	15 mg/m³

Note -- Conversion factors - mppcf X 35.3 = million particles per cubic meter = particles per c.c.

[a] Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

[b] The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

[c] Containing less than 1% quartz; if 1% quartz or more, use quartz limit.

[d] All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by this limit, which is the same as the Particulates Not Otherwise Regulated (PNOR) limit in Table Z-1.

[e] Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC (now NRC) instrument. The respirable fraction of coal dust is determined with an MRE; the figure corresponding to that of 2.4 mg/m^3 in the table for coal dust is 4.5 mg/m^3.

[Note: This document was changed to an html version as of 11/24/2004]
[58 FR 35340, June 30, 1993; 58 FR 40191, July 27, 1993, as amended at 61 FR 56831, Nov. 4, 1996; 62 FR 1600, Jan. 10, 1997; 62 FR 42018, Aug. 4,1997]

APPENDIX F

LIST OF KNOWN OR ANTICIPATED CARCINOGENS

The following is a compilation of chemical substances listed by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP).

This list does not include exposure circumstances (e.g., manufacture of auramine) that are included in NTP and IARC documents.

A

A-alpha-C (2-Amino-9*H*-pyrido[2,3-*b*]indole)
Acetaldehyde
Acetamide
2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Adriamycin® (Doxorubicin Hydrochloride)
AF-2 [2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide]
Aflatoxin M1
Aflatoxins
Alcoholic Beverage Consumption
para-Aminoazobenzene
ortho-Aminoazotoluene
2-Aminoanthraquinone
o-Aminoazotoluene
4-Aminobiphenyl
1-Amino-2,4-dibromoanthraquinone
1-Amino-2-methylanthraquinone
2-Amino-3,4-dimethylimidazo[4,5-*f*]quinoline (MeIQ)
2-Amino-3,8-dimethylimidazo[4,5-*f*]quinoxaline (MeIQx)
2-Amino-3-methylimidazo[4,5-*f*]quinoline (IQ)
2-Amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine (PhIP)
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole
Amitrole
Amsacrine
Analgesic mixtures containing phenacetin
Androgenic (anabolic) steroids
o-Anisidine Hydrochloride
Antimony trioxide
Aramite®
Auramine
Azaserine
Aziridine
Areca nut
Aristolochic acids (naturally occurring mixtures of)
Arsenic Compounds, Inorganic
Asbestos
Azacitidine (5-Azacytidine®, 5-AzaC)
Azathioprine

B
Benz[*a*]anthracene (See Polycyclic Aromatic Hydrocarbons)
Benzene
Benzidine (See Benzidine and Dyes Metabolized to Benzidine)
Benzidine-based dyes
Benzo[*b*]fluoranthene (See Polycyclic Aromatic Hydrocarbons)
Benzo[*j*]fluoranthene (See Polycyclic Aromatic Hydrocarbons)
Benzo[*k*]fluoranthene (See Polycyclic Aromatic Hydrocarbons)
Benzofuran
Benzo[*a*]pyrene (See Polycyclic Aromatic Hydrocarbons)
Benzotrichloride
Benzyl violet 4B
Beryllium and Beryllium Compounds
N,*N*-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)
Betel quid with tobacco
Betel quid without tobacco
Bitumens
Bleomycins
Bracken fern
2,2-bis-(Bromoethyl)-1,3-propanediol (Technical Grade)
Bromodichloromethane
1,3-Butadiene
1,4-Butanediol Dimethanesulfonate (Myleran®)
Butylated Hydroxyanisole (BHA)
beta-Butyrolactone

C
Cadmium and Cadmium Compounds
Caffeic acid
Captafol
Carbon black
Carbon Tetrachloride
Carrageenan
Catechol
Ceramic Fibers (Respirable Size)
Chlorambucil
Chloramphenicol
Chlordane
Chlordecone (Kepone)
Chlorendic Acid
Chlorinated Paraffins (C12, 60% Chlorine)
alpha-Chlorinated toluenes (benzal chloride, benzotrichloride, benzyl chloride) and benzoyl chloride (combined exposures)
para-Chloroaniline
3-Chloro-4-(dichloromethyl)-5-hydroxy-2(*5H*)-furanone

1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (MeCCNU)
bis(Chloromethyl) Ether and Technical-Grade Chloromethyl Methyl Ether
bis(Chloroethyl) nitrosourea
Chloroform
1-Chloro-2-methylpropene
3-Chloro-2-methylpropene
4-Chloro-*ortho*-toluidine
4-Chloro-*o*-phenylenediamine
Chlorophenoxy herbicides
4-Chloro-*ortho*-phenylenediamine
Chloroprene
Chlorothalonil
p-Chloro-*o*-toluidine and *p*-Chloro-*o*-toluidine Hydrochloride
Chlorozotocin
Chromium Hexavalent Compounds
CI Acid Red 114
CI Basic Red 9 Monohydrochloride
CI Direct Blue 15
Citrus Red No. 2
Cisplatin
Cisplatin *Clonorchis sinensis* (infection with)
Coal Tar Pitches (See Coal Tars and Coal Tar Pitches)
Coal Tars (See Coal Tars and Coal Tar Pitches)
Cobalt and cobalt compounds
Cobalt Sulfate
Coffee
Coke Oven Emissions
Creosotes (from coal-tars)
p-Cresidine
Cupferron
Cycasin
Cyclophosphamide
Cyclosporin A

D
Dacarbazine
Danthron (1,8-Dihydroxyanthraquinone)
Daunomycin
N,*N*′-Diacetylbenzidine
2,4-Diaminoanisole Sulfate
4,4'-Diaminodiphenyl ether
2,4-Diaminotoluene
Diazoaminobenzene
Dibenz[*a,h*]acridine (See Polycyclic Aromatic Hydrocarbons)
Dibenz[*a,j*]acridine (See Polycyclic Aromatic Hydrocarbons)

Dibenz[*a,h*]anthracene (See Polycyclic Aromatic Hydrocarbons)
7*H*-Dibenzo[*c,g*]carbazole (See Polycyclic Aromatic Hydrocarbons)
Dibenzo[*a,e*]pyrene (See Polycyclic Aromatic Hydrocarbons)
Dibenzo[*a,h*]pyrene (See Polycyclic Aromatic Hydrocarbons)
Dibenzo[*a,i*]pyrene (See Polycyclic Aromatic Hydrocarbons)
Dibenzo[*a,l*]pyrene (See Polycyclic Aromatic Hydrocarbons)
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane (Ethylene Dibromide)
2,3-Dibromo-1-propanol
tris(2,3-Dibromopropyl) Phosphate
Dichloroacetic acid
para-Dichlorobenzene
1,4-Dichlorobenzene
3,3´-Dichlorobenzidine and 3,3´-Dichlorobenzidine Dihydrochloride
3,3'-Dichloro-4,4'-diaminodiphenyl ether
Dichlorodiphenyltrichloroethane (DDT)
1,2-Dichloroethane (Ethylene Dichloride)
Dichloromethane (Methylene Chloride)
1,3-Dichloropropene (Technical Grade)
Dichlorvos
Diepoxybutane
1,2-Diethylhydrazine
Diesel Exhaust Particulates
Diethyl Sulfate
Diethylstilbestrol
Diglycidyl Resorcinol Ether
Dihydrosafrole
Diisopropyl sulfate
4-Dimethylaminoazobenzene
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)-vinyl]-1,3,4-oxadiazole
2,6-Dimethylaniline (2,6-Xylidine)
3,3´-Dimethylbenzidine (See 3,3´-Dimethylbenzidine and Dyes Metabolized to 3,3´-Dimethylbenzidine)
Dimethylcarbamoyl Chloride
3,3´-Dimethoxybenzidine (See 3,3´-Dimethoxybenzidine and Dyes Metabolized to 3,3´-Dimethoxybenzidine)
1,1-Dimethylhydrazine
1,1-Dimethylhydrazine
1,2-Dimethylhydrazine
Dimethyl Sulfate
Dimethylvinyl Chloride
3,7-Dinitrofluoranthene
3,9-Dinitrofluoranthene
1,6-Dinitropyrene (See Nitroarenes (selected))
1,8-Dinitropyrene (See Nitroarenes (selected))
2,4-Dinitrotoluene

2,6-Dinitrotoluene
1,4-Dioxane
Disperse Blue 1
Dyes Metabolized to Benzidine (See Benzidine and Dyes Metabolized to Benzidine)
Dyes Metabolized to 3,3′-Dimethoxybenzidine (See 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)
Dyes Metabolized to 3,3′-Dimethylbenzidine (See 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)

E
Epichlorohydrin
Engine exhaust, gasoline
Environmental Tobacco Smoke (See Tobacco Related Exposures)
1,2-Epoxybutane
Epstein-Barr virus
Erionite
Estrogens, Steroidal
Ethyl acrylate
Ethylbenzene
Ethylene dibromide
Ethylene Oxide
N-Ethyl-*N*-nitrosourea
Etoposide in combination with cisplatin and bleomycin
Ethylene Thiourea
di(2-Ethylhexyl) Phthalate
Ethyl Methanesulfonate

F
Foreign bodies, implanted in tissues (Vol. 74; 1999)
    Polymeric, prepared as thin smooth films (with the exception of poly(glycolic acid))
    Metallic, prepared as thin smooth films
    Metallic cobalt, metallic nickel and an alloy powder containing 66-67% nickel, 13-16% chromium and 7% iron
Formaldehyde (Gas)
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole
Fuel oils, residual (heavy)
Fumonisin B_1
Furan

G
Gallium arsenide
Gasoline
Glass Wool (Respirable Size)
Glu-P-1 (2-Amino-6-methyldipyrido[1,2-*a*:3',2'-*d*]imidazole)

Glu-P-2 (2-Aminodipyrido[1,2-*a*:3',2'-*d*]imidazole)
Glycidaldehyde
Glycidol
Griseofulvin

H
HC Blue No. 1
Helicobacter pylori (infection with)
Heptachlor
Hepatitis B Virus
Hepatitis C Virus
Herbal remedies containing plant species of the genus *Aristolochia*
Hexachlorobenzene
Hexachlorocyclohexane Isomers (See Lindane and Other Hexachlorocyclohexane Isomers)
Hexachloroethane
Hexamethylphosphoramide
Hot mate
Hydrazine and Hydrazine Sulfate
Hydrazobenzene
Human immunodeficiency virus type 1 (infection with)
Human immunodeficiency virus type 2 (infection with)
Human Papillomas Viruses: Some Genital-Mucosal Types
Human papillomaviruses: some types other than 16, 18, 31 and 33
1-Hydroxyanthraquinone

I
Indeno[1,2,3-*cd*]pyrene (See Polycyclic Aromatic Hydrocarbons)
Indium phosphide IQ (2-Amino-3-methylimidazo[4,5-*f*]quinoline)
Iron Dextran Complex
Isoprene

K
Kaposi's sarcoma herpesvirus/human herpesvirus 8 (Vol. 70; 1997)
Kepone® (Chlordecone)

L
Lasiocarpine
Lead and Lead Compounds
Lindane and Other Hexachlorocyclohexane Isomers

M
Magenta (containing CI Basic Red 9)
Magnetic fields (extremely low-frequency)
MeA-□-C (2-Amino-3-methyl-9*H*-pyrido[2,3-*b*]indole)
Medroxyprogesterone acetate
MeIQ (2-Amino-3,4-dimethylimidazo[4,5-*f*]quinoline)

MeIQx (2-Amino-3,8-dimethylimidazo[4,5-*f*]quinoxaline)
Melphalan
Merphalan
5-Methoxypsoralen
8-Methoxypsoralen (Methoxsalen) plus ultraviolet A radiation
Methoxsalen with Ultraviolet A Therapy (PUVA)
2-Methylaziridine (Propylenimine)
Methylazoxymethanol acetate
5-Methylchrysene (See Polycyclic Aromatic Hydrocarbons)
4,4′-Methylenebis(2-chloroaniline)
4-4′-Methylenebis(*N,N*-dimethyl)benzenamine
4,4'-Methylene bis(2-methylaniline)
4,4′-Methylenedianiline and Its Dihydrochloride Salt
Methyleugenol
Methyl Methanesulfonate
Methylmercury compounds
2-Methyl-1-nitroanthraquinone
N-Methyl-*N′*-nitro-*N*-nitrosoguanidine
N-Methyl-*N*-nitrosourea
N-Methyl-*N*-nitrosourethane
Nitrogen mustard
N-Nitrosodiethylamine
Methylthiouracil
Metronidazole
Michler´s Ketone [4,4′-(Dimethylamino)benzophenone]
Mineral Oils (Untreated and Mildly Treated)
Mirex
Mitomycin C
Mitoxantrone
Monocrotaline
MOPP and other combined chemotherapy including alkylating agents
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone
Mustard Gas

N
Nafenopin
Naphthalene
2-Naphthylamine
Neutrons (See Ionizing Radiation)
Nickel Compounds (See Nickel Compounds and Metallic Nickel)
Niridazole
Nitrilotriacetic Acid
5-Nitroacenaphthene
2-Nitroanisole
o-Nitroanisole
Nitrobenzene

6-Nitrochrysene (See Nitroarenes (selected))
Nitrofen (2,4-Dichlorophenyl-*p*-nitrophenyl ether)
2-Nitrofluorene
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide
Nitrogen Mustard Hydrochloride
Nitrogen mustard *N*-oxide
Nitromethane
2-Nitropropane
1-Nitropyrene (See Nitroarenes (selected))
4-Nitropyrene (See Nitroarenes (selected))
N-Nitrosodi-*n*-butylamine
N-Nitrosodiethanolamine
N-Nitrosodiethylamine
N-Nitrosodimethylamine
N-Nitrosodi-*n*-propylamine
N-Nitroso-*N*-ethylurea
4-(*N*-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone
3-(*N*-Nitrosomethylamino)propionitrile
N-Nitrosomethylethylamine
N-Nitroso-*N*-methylurea
N-Nitrosomethylvinylamine
N-Nitrosomorpholine
N-Nitrosonornicotine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
N-Nitrososarcosine
Non-arsenical insecticides (occupational exposures in spraying and application of)
Norethisterone

O

Ochratoxin A
Oestrogen therapy, postmenopausal
Oestrogens, nonsteroidal (NB: This evaluation applies to the group of compounds as a whole and not necessarily to all individual compounds within the group)
Oestrogens, steroidal (NB: This evaluation applies to the group of compounds as a whole and not necessarily to all individual compounds within the group)
Oil Orange SS
Opisthorchis viverrini (infection with)
Oral contraceptives, combined (NB: There is also conclusive evidence that these agents have a protective effect against cancers of the ovary and endometrium)
Oral contraceptives, sequential
Oxazepam
4,4´-Oxydianiline
Oxymetholone

P
Palygorskite (attapulgite)
Panfuran S
Phenacetin (See Phenacetin and Analgesic Mixtures Containing Phenacetin)
Phenazopyridine Hydrochloride
Phenobarbital
Phenolphthalein
Phenoxybenzamine Hydrochloride
Phenyl glycidyl ether
Phenytoin
PhIP (2-Amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine)
Phosphorus-32, as phosphate
Pickled vegetables (traditional in Asia)
Plutonium-239 and its decay products (may contain plutonium-240 and other isotopes), as aerosols
Polybrominated Biphenyls (PBBs)
Polychlorinated Biphenyls (PCBs)
Polychlorophenols and their sodium salts (mixed exposures)
Polycyclic Aromatic Hydrocarbons (PAHs)
Ponceau MX
Ponceau 3R
Potassium bromate
Procarbazine Hydrochloride
Progesterone
Progestins
1,3-Propane Sultone
beta-Propiolactone
Propylene Oxide
Propylthiouracil

R
Radioiodines, short-lived isotopes, including iodine-131, from atomic reactor accidents and nuclear weapons detonation (exposure during childhood)
Radionuclides, a-particle-emitting, internally deposited (NB: Specific radionuclides for which there is *sufficient* evidence for carcinogenicity to humans are also listed individually as Group 1 agents)
Radionuclides, b-particle-emitting, internally deposited (NB: Specific radionuclides for which there is *sufficient* evidence for carcinogenicity to humans are also listed individually as Group 1 agents)
Radium-224 and its decay products
Radium-226 and its decay products
Radium-228 and its decay products
Radon-222 [10043-92-2] and its decay products
Radon (See Ionizing Radiation)
Refractory ceramic fibres
Riddelliine
Reserpine

S
Safrole
Salted fish (Chinese-style)
Schistosoma haematobium (infection with)
Schistosoma japonicum (infection with)
Selenium Sulfide
Shale-oils
Silica, Crystalline (Respirable Size)
Smokeless Tobacco (See Tobacco Related Exposures)
Sodium *ortho*-phenylphenate
Solar Radiation (See Ultraviolet Radiation Related Exposures)
Soots
Special-purpose fibres such as E-glass and '475' glass fibres
Sterigmatocystin
Streptozotocin
Styrene
Strong Inorganic Acid Mists Containing Sulfuric Acid
Styrene-7,8-oxide
Sulfallate
Sunlamps or Sunbeds, Exposure to (See Ultraviolet Radiation Related Exposures)

T
Talc containing asbestiform fibres
Tamoxifen
Toxaphene (Polychlorinated camphenes)
Teniposide
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD); “Dioxin”
Tetrachloroethylene (Perchloroethylene)
Tetrafluoroethylene
Tetranitromethane
Thioacetamide
4,4´-Thiodianaline
Thiotepa
Thiouracil
Thiourea
Thorium Dioxide (See Ionizing Radiation)
Toluene Diisocyanate
o-Toluidine and *o*-Toluidine Hydrochloride
Toxaphene
Toxins derived from *Fusarium moniliforme*
Treosulfan
Trichloroethylene
Trichlormethine (Trimustine hydrochloride)
2,4,6-Trichlorophenol
1,2,3-Trichloropropan

Tris(2,3-dibromopropyl) phosphate
Trp-P-1 (3-Amino-1,4-dimethyl-5*H*-pyrido[4,3-*b*]indole)[62450-06-0]
Trp-P-2 (3-Amino-1-methyl-5*H*-pyrido[4,3-*b*]indole)[62450-07-1]
Trypan blue
Tobacco Smoking (See Tobacco Related Exposures)

U
Uracil mustard
Ultraviolet A Radiation (See Ultraviolet Radiation Related Exposure)
Ultraviolet B Radiation (See Ultraviolet Radiation Related Exposure)
Ultraviolet C Radiation (See Ultraviolet Radiation Related Exposure)
Urethane

V
Vanadium pentoxide
Vinyl acetate
Vinyl Bromide
Vinyl Chloride
4-Vinyl-1-cyclohexene Diepoxide
4-Vinylcyclohexene
Vinyl Fluoride

W
Welding fumes
Wood Dust

X
X-Radiation and Gamma Radiation (See Ionizing Radiation)

Z
Zalcitabine
Zidovudine (AZT)