OCCUPATIONAL EXPOSURES TO HAZARDOUS CHEMICALS IN LABORATORIES

CHEMICAL HYGIENE PLAN

YESHIVA UNIVERSITY
and
ALBERT EINSTEIN COLLEGE of MEDICINE

Prepared by:
The Department of Environmental Health and Safety

Revised: July, 2011

CHEMICAL HYGIENE PLAN

1 INTRODUCTION

It is the intent of Yeshiva University (YU) to provide a safe and healthful work environment for all of its employees, students, and visitors. In order to achieve this aim, the management at YU supports the goals of the Chemical Hygiene Plan. This plan is designed to protect employees from health hazards associated with hazardous chemicals in the laboratory and to keep any chemical exposure below the action level or permissible exposure limit (PEL).

It is the responsibility of the Principal Investigator/Supervisor to ensure that the goals and conditions of the Chemical Hygiene Plan are strictly followed by all employees under their supervision. It is the employee's responsibility to incorporate the practices and requirements outlined in the Chemical Hygiene Plan into their daily activities. It is the Department of Environmental Health and Safety's (EH&S') responsibility to administer the university-wide Chemical Hygiene Plan.

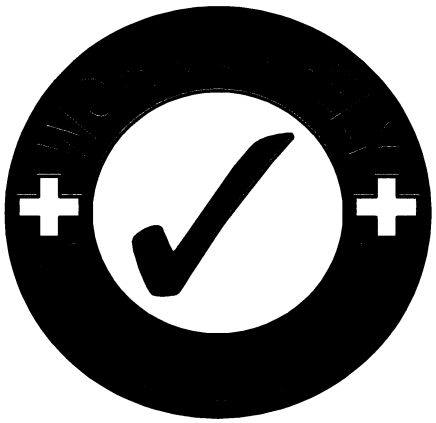
1.1 History of the OSHA Laboratory Standard

On November 25, 1983, the Occupational Safety and Health Administration (OSHA) published the Hazard Communication Standard which applied to certain manufacturers and laboratories. OSHA received many comments regarding whether the Hazard Communication Standard should apply to laboratories where the staff is highly educated. Other unique differences for laboratories were noted including: the small amounts of chemicals used; the vast numbers of different chemicals involved; and nearly half of the laboratories in one survey could not accurately predict their chemical needs even one month in advance.

OSHA decided that "...Despite the existence of the unique characteristics of laboratory work places, in actual practice incidents of acute adverse health effects resulting from exposures to toxic substances in laboratories do occur. Furthermore, some studies... have shown increased risks of certain types of diseases for laboratory workers. In addition, although laboratory workers are, in general, a well-educated work force, there is evidence that many laboratories do not have health and safety programs..." and "...there is some question as to whether laboratory workers actually make themselves as knowledgeable as they should be and some laboratory employees are not professionally trained."

As a result, OSHA promulgated the "Occupational Exposures to Hazardous Chemicals in Laboratories" rule commonly known as the Laboratory Standard. The effective date of the standard, 29 CFR 1910.1450, was May 1, 1990. As part of that standard, laboratories are required to develop and implement a Chemical Hygiene Plan.

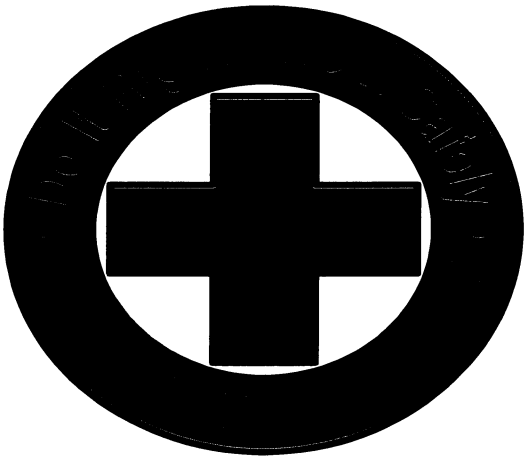
1.2 Role of the Chemical Hygiene Plan



This Chemical Hygiene Plan describes YU's program, including, but not limited to, personal protective equipment, control equipment (such as vented hoods), employee training programs, medical programs, and safety inspections relating to the use of hazardous chemicals in our laboratories. The Chemical Hygiene Plan is supplemented by safety procedural notes included in test methods used (examples: ASTM, EPA Test Methods, or Standard Methods...). The Chemical Hygiene Plan is designed as a tool to coordinate safety procedures. The principal investigator/supervisor establishes laboratory procedures. The Department of Environmental Health and Safety and the Chemical Hazards and Storage Committee review and evaluate those procedures. Every employee in the laboratory must be trained in the applicable details of this plan. The principal investigators/supervisors must ensure that each employee is trained to their specific laboratory procedure and that proper safety procedures are followed.

2 DESCRIPTION OF YESHIVA UNIVERSITY AND THE ALBERT EINSTEIN COLLEGE OF MEDICINE OF YESHIVA UNIVERSITY

Yeshiva University is composed of two High Schools, an Undergraduate School, a Business School, a Women's College, a Law School, and a Medical School. The Albert Einstein College of Medicine of Yeshiva University (Einstein) is a Medical School, a Graduate School, a Medical Research Institution, and includes Associated Clinics.



3 RESPONSIBILITIES FOR THE CHEMICAL HYGIENE PLAN (CHP)

3.1 Chemical Hygiene Plan Contacts

Industrial Hygienist/Chemical Hygiene Officer	Einstein	(718) 430-4152
Safety Specialist	YU Einstein	(212) 923-0784 (718) 430-3529
Laboratory Safety Officer	Einstein	(718) 430-3560
Senior Director of Environmental Health and Safety	YU Einstein	(718) 430-4150
Fire Safety Officer	Einstein	(718) 430-2031
Occupational Health Services	Einstein	**(718) 430-3141**

3.1.1 Industrial Hygienist/Chemical Hygiene Officer/Safety Specialist/Laboratory Safety Officer/Fire Safety Officer

A. Develops and updates the Chemical Hygiene Plan and appropriate policies and practices.
B. Provides technical assistance in complying with the Chemical Hygiene Plan and answers safety questions for employees.
C. Assists Investigators/Supervisors in developing appropriate safety precautions for new projects and procedures in conjunction with the Institutional Chemical Hazards and Storage Committee.
D. Ensures that employees comply with the Chemical Hygiene Plan.
E. Ensures that appropriate personal protective equipment is available as needed.
F. Monitors proper functioning of engineering controls such as fume hoods and arranges for prompt repairs as needed.
G. Performs workplace inspections.
H. Gathers and maintains manufacturers' Material Safety Data Sheets or electronic MSDSs.
I. Develops and implements a labeling program.
J. Responds to exposure complaints.
K. Monitors chemical exposure of employees.

3.1.2 Laboratory Safety Officer

A. Monitors procurement of new chemicals.
B. Monitors collection and disposal of chemical wastes.
C. Reviews chemical inventory to determine which chemicals are carcinogens.
D. Conducts laboratory inspections.
E. Reviews Research Grant Applications.

3.1.3 Fire Safety Officer

A. Assures fire safety in all buildings.
B. Conducts building and laboratory inspections.

3.1.4 Senior Director of Environmental Health and Safety

A. Remains current on developing regulations concerning chemicals used in YU and Einstein.
B. Oversees the Industrial Hygiene, Safety Specialist, Laboratory Safety, and Fire Safety positions.

3.1.5 Occupational Health Services

A. Responds to medical conditions relating to occupational exposure.
B. Conducts Medical Monitoring of employees.

3.2 Responsibilities of Each Employee Working with Hazardous Chemicals

Each employee and student is responsible for knowing how to handle a hazardous chemical safely according to its type of hazards. If there is any uncertainty concerning a chemical's hazard or its safe handling, it is the employees responsibility to ask a supervisor or a health and safety professional. Each employee is also responsible for ensuring that all chemicals are correctly labeled.

4 CHEMICAL HYGIENE AND SAFETY PLAN PROCEDURES AND PRACTICES

4.1 General Standard Operating Procedures

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

4.1.1 General Rules

A. Awareness is the most fundamental rule of chemical safety. Everyone should remain constantly aware of:
   a. The chemical's hazard, as determined from the bottle label, MSDS, Principal Investigator/Supervisor, and other appropriate references.
   b. Safeguards for using that chemical, including personal protective equipment and engineering controls.
   c. Location and proper use of emergency equipment.
   d. How and where to properly store the chemical when not in use.

(Remember: The chemical is actually used for only minutes in the average workday; the rest of the time it is being "stored" on the laboratory bench or in the cabinet below the fume hood.)

e. Proper personal hygiene practices.

f. The proper methods of transporting chemicals within the facility.

g. Appropriate procedures for emergencies including evacuation routes, spill clean up procedures, and proper waste disposal.

B. Prudent practice dictates that one should not work alone in the laboratory. If solitary work is necessary, inform someone else of your location.

4.1.2 General Practices for Using Hazardous Chemicals

A. Order the correct amount of a chemical. Excessive amounts of hazardous chemicals create storage, use, and disposal problems.

B. Wear the appropriate personal protective equipment (e.g., laboratory coat, gloves, goggles, disposable sleeves, and shoes).

C. Weigh or measure hazardous chemicals in the chemical fume hood.

D. Clearly label all secondary containers and store in a ventilated storage cabinet.

E. Procedures which may generate aerosols or vapor must be conducted in the chemical fume hood.

F. Collect hazardous waste in a labeled container and transfer to the designated storage area.

G. Wash hands thoroughly after chemical use and when you leave the laboratory.

H. In the event of personal contamination or a spill, contact your supervisor and/or instructor and notify EH&S.

I. Review procedures with the research supervisor whenever there are any changes in operation or results.

J. Wash work surface after each use.

K. Be aware of the safety hazards of the chemicals in your workplace. Know the proper emergency procedures.

4.1.3 General Chemical Transportation Procedures

A. Chemicals are transported in original packaging from the manufacturers directly to the laboratories in the approved transport packaging.

B. Chemicals from YU's Central Supply are transported between laboratories with approved safety carriers.

C. YU's central chemical supply provides chemicals in shatter-proof bottles

D. Chemicals cannot be transported in personal vehicles.

4.1.4 Personal Hygiene

Personal hygiene is an important factor in safety. Proper protection can eliminate a chemical's ability to do harm. Use the following personal hygiene practices:

A. Wash promptly with soap and water for at least 15 minutes if skin contact is made with any chemical.

B. Wear appropriate eye protection at all times.

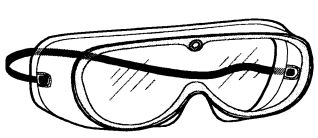
C. Avoid inhalation of chemicals; do not "sniff" known or unknown chemicals.
D. Do not mouth pipette. Use suction bulbs or other mechanical pipettes.
E. Wash well with soap and water before leaving the laboratory.
F. Change clothing as soon as possible after leaving the laboratory. Launder work clothes separately.
G. Do not eat, smoke, or apply cosmetics in laboratories or storage areas.
H. Do not wear gloves outside the laboratory.

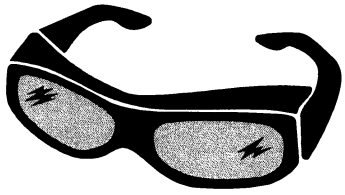
4.1.5 Food and Smoking

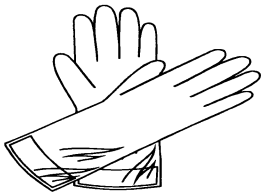
A. Food, drink, and especially tobacco, absorb chemical vapors and gases from the air. Do not bring food, beverages, or tobacco products into areas where chemicals are used or into chemical storage areas.
B. No smoking is permitted in any laboratory area.

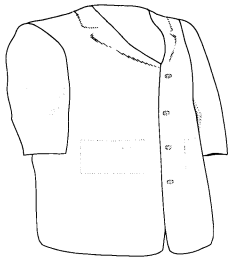
4.1.6 Protective Clothing and Equipment

A. Most personal protective equipment is provided by YU to employees when necessary. It is the responsibility of each employee and principal investigator/supervisor to be certain that the appropriate equipment is worn.
B. Clothing should be worn to minimize exposed skin surfaces to prevent direct contact through splashing. All employees should wear long sleeved/long legged clothing and avoid skirts and sandals.
C. Additional equipment is available through your supervisor and/or EH&S including:
   a. Eye wear
   b. Lab coats
   c. Gloves
   d. Aprons
   e. Face shields
   f. Respirators









D. The proper uses and maintenance of the equipment is discussed in Section 4.4 Control Measures and Equipment.

4.1.7 Housekeeping

A. Common housekeeping practices contribute greatly towards chemical hygiene and safety. Some appropriate housekeeping measures:
   a. Keep all aisles, hallways, and stairs clear of all chemicals and debris.
   a. Keep all work areas clear of clutter and obstructions.
   b. Keep all working surfaces and floors cleaned.
   c. Never block access to emergency equipment, showers, eyewashes and exits.
   d. Keep waste in the proper closed containers and labeled correctly.

B. The typical housekeeping staff is not trained on the hazards of individual laboratory chemicals. For the safety of the housekeeping staff, laboratory workers should ensure that:
   a. Chemicals are placed in the proper storage areas.
   b. Chemical containers are labeled with both the identity of the chemical and its hazards.
   c. Secondary chemical containers are properly labeled with the identity of the chemical and its hazards.
   d. Spills are promptly cleaned up by lab personnel or EH&S (if the spill is large) and the waste is properly disposed. Notify EH&S about any spill at YU at (212) 923-0784 or (718) 430-3529 or at Einstein (718) 430-4150.

4.1.8 Guidelines for New Procedures

A. It is the responsibility of the Principal Investigator/Supervisor to inform his/her employees and EH&S when there are changes in laboratory procedures or practices which may create an environmental or occupational health hazard.

B. EH&S must be notified whenever:
   a. There is a failure of any safety equipment such as fume hoods.
   b. There is a change in the type of hazardous chemical used.
   c. Where members of the laboratory staff suspects exposure to a chemical.

C. Any new procedure should be subjected to peer review, not only from a scientific stand point, but also to assure that all safety considerations are in place prior to implementation. The Institutional Chemical Hazards and Storage Committee and EH&S are available for assistance. The appropriate time for this review is when a grant application for a specific research project is being submitted. See EH&S for the appropriate research project evaluation form (Appendix M).

4.1.9 Hazardous Waste

A. Hazardous wastes are regulated by the U.S. Environmental Protection Agency under the Resource Conservation and Recovery Act and its amendments. In N.Y.S., this responsibility is turned over to the N.Y.S. Department of

Environmental Conservation.

B. All employees should be advised by their supervisor on how to handle hazardous wastes. EH&S will assist you in chemical disposal. Call (212) 923-0784 at YU or (718) 430-4150 at Einstein.

C. Hazardous Wastes shall NOT be disposed down the sink drain.

D. Waste containers must be properly labeled. (See Appendix L Chemical Waste Labels.)

4.2 Specific Safety Procedures

Written laboratory procedures can be obtained from the Principal Investigator/Supervisor in each area. EH&S and the Institutional Chemical Hazards and Storage Committee can assist you in reviewing laboratory procedures.

4.2.1 Working with Allergens and Reproductive Toxins

Review each use of these materials with the Principal Investigator/Supervisor. Review continuing use annually or whenever a procedural change is made. Store these properly-labeled substances, in an unbreakable secondary container in an adequately-ventilated area. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

A. Allergens - (examples: *diazomethane, isocyanates, bichromates*) Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity.

B. Reproductive toxins - (examples: *DES, organomercurials*, lead compounds, *formamide*). If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves and lab coat) to prevent skin contact.

4.2.2 Requirements for Work with Select Agent Toxins

Select Agent Toxins are biologically derived toxic chemicals that are specifically regulated by the federal U.S. Department of Health and Human services under regulation 42 CFR Part 73 when handled at levels above the specific quantities listed in the chart below. The following table provides the toxins and the limitations for working with each toxin. For any research requiring purchase, storage, or use of more than the quantities listed in this table, the researcher must apply for a license to the Center for Disease Control (CDC) and must be approved by the Institutional Biosafety Committee (IBC).

TOXIN	Max Allowed
Abrin	100 mg
Botulinum neurotoxin	0.5 mg
Clostridium perfringens epsilon toxin	100 mg
Conotoxins	100 mg
Diacetoxyscirpenol (DAS)	1000 mg
Ricin	100 mg
Saxitoxin	100 mg
Shigatoxin and Shiga-like ribosome inactivating proteins	100 mg
Staphylococcus enterotoxins	5 mg
Tetrodotoxin	100 mg
T-2 Toxin	1000 mg

These materials are highly toxic and special precautions must be taken whenever handling concentrated forms, even in small amounts. Regulatory exempt quantities of these stock toxins should be stored under lock and key. A log must be maintained that tracks the use of these materials. Researchers wanting to work with these materials should contact the Department of Environmental Health and Safety for more information.

The laboratory facilities, equipment, and procedures appropriate for work with toxins of biological origin must reflect the intrinsic level of hazard posed by a particular toxin as well as the potential risks inherent in the operation performed. This is called a risk assessment. If both toxins and infectious agents are used, both must be considered when containment equipment is selected and policies and procedures are written. If animals are used, animal safety practices must also be considered.

Access to areas containing toxins must be restricted to those individuals whose work require access. Preparation of primary containers of toxin stock solutions and manipulations of primary containers of dry forms of toxins should be conducted in a chemical fume hood or a biological safety cabinet. HEPA and/or charcoal filtration of the exhaust air may be required or some other form of tapping mechanism, depending on the toxin.

Any special entry requirements must be posted on the entrance(s) to the room. Only personnel whose presence is required must be permitted in the room while toxins are in use. All high risk operations must be conducted with two knowledgeable individuals present. Each must be familiar with the applicable procedures, maintain visual contact with the other, and be ready to assist in the event of an accident.

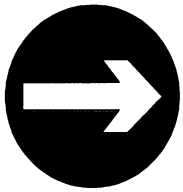
Before containers are removed from the hood, the exterior of the closed primary container must be decontaminated and placed in a clean, secondary container. Toxins must be transported only in leak/spill-proof secondary containers. Contaminated and potentially contaminated protective clothing and equipment must be decontaminated using methods known to be effective against the toxin before removal from the laboratory for disposal, cleaning, or repair. Contaminated materials must be autoclaved or otherwise rendered non-infectious before leaving the laboratory. The interior of the hood must be decontaminated periodically.

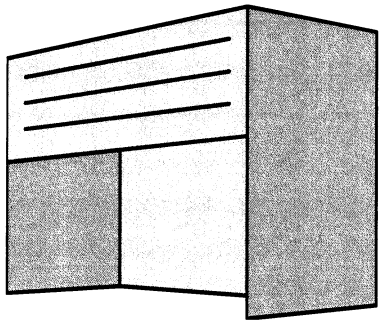
PPE must be worn when handling toxins. PPE must include gloves and a disposable long-sleeved body covering (gown, laboratory coat, smock, coverall, or similar garment) must be worn so that hands and arms are completely covered. Eye protection should be worn if there is a risk of ocular exposure.

4.2.3 Working with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisoproplyflurophosphate, hydrofluoric acid, cyanide, azidotrimethylsilane

A. General Procedures -
   a. Always work with chemicals in an operational fume hood.
   b. At least two people must be present at all times if a compound in use is highly toxic or of unknown toxicity.
   c. Store breakable containers of these substances in chemically resistant trays.
   d. Always wash hands and arms, with soap and water, immediately after working with these materials.
   e. Be prepared for accidents and spills. If a major spill occurs outside the hood, call EH&S at (718) 430-4150.





B. Personal protection
   a. Always use the appropriate gloves and wear long sleeve shirts and a lab coat. Check the glove compatibility for each chemical. Be aware that some gloves are not suitable for certain chemicals.
   b. Use appropriate eye protection such as safety glasses, goggles, and face shields.

C. Waste - For complete information on waste disposal please refer to the YU Waste

Disposal Guidelines Manual for YU and the Einstein Waste Disposal Guidelines for Einstein. Both are available from EH&S.

a. Store contaminated waste in closed, suitably labeled, impervious containers.

b. Label all waste with a hazardous waste label. Include the chemical name, amount, and date of accumulation. (See Appendix L Waste Labels.)

D. Record - Maintain inventory records.

4.2.4 Working with Chemicals of High Chronic Toxicity

(Examples: *dimethylmercury, nickel carbonyl, benzo-a-pyrene, nitrosodiethylamine*, or substances with high carcinogenic potency in animals.)

For work with substances of known high chronic toxicity in quantities above a few milligrams to a few grams, depending on the substance:

A. Work with these substances must be under the supervision of the area Principal Investigator/Supervisor. Approvals for projects may be obtained from the Institutional Chemical Hazards and Storage Committee or EH&S.

B. Conduct all transfers and work in a posted operational fume hood or glove box. People in the area must be aware of the substances being used and the necessary precautions to be taken. Laboratories where the above chemicals are used are considered controlled areas.

C. Non-Contamination/Decontamination: In order to protect vacuum pumps from contamination use scrubbers or HEPA filters and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment in the hood before removing them from the controlled area. Decontaminate any contaminated equipment in the controlled area before normal work is resumed.

D. Exiting: On leaving a controlled area, remove any protective apparel; wash hands, forearms, face, and neck.

E. Mechanical surveillance: If using toxicologically significant quantities of a substance on a regular basis, consult with the Institutional Chemical Hazards and Storage Committee, EH&S, your principal investigator/supervisor or Occupational Health Service concerning the desirability of regular medical surveillance.

F. Work area should be appropriately posted and all containers properly labeled.

G. Spills: Immediately notify EH&S (212) 923-0784 at YU or (718) 430-4150 and Einstein.

H. Storage: Store containers of these chemicals in a ventilated, limited access area.

Use appropriately labeled, unbreakable, chemically resistant, containers.

I. Glove boxes: For a negative pressure glove box, the ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water. For a positive pressure glove box, thoroughly check for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood.

J. Waste: Arrange for EH&S to remove this waste.

K. Check compatibility before mixing chemicals.

4.2.5 Animal Work with Chemicals of High Chronic Toxicity

A. Access: For large scale studies, special facilities with restricted access are preferable.

B. Administration: When possible, administer the substance by injection or lavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters.

C. Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces. Use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood.

D. Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit, and other necessary equipment.

E. Waste disposal: Dispose of contaminated animal tissues and excreta as pathological waste for incineration. Consult with Einstein's Waste Disposal Guidelines if you have any questions.

4.3 Special Procedures for Carcinogens

4.3.1 Background

A. OSHA has noted that many laboratory workers use known or suspected carcinogens.

B. Exposures to multiple carcinogens can have synergistic effects on health. To limit possible exposures, YU has special procedures and precautions for work with carcinogens.

C. See Appendix B for a List of Carcinogens Used at YU.

4.3.2 Regulated and Controlled Work Areas

A. Special work areas are designated for work with carcinogens.
B. These rooms, including storage areas for chemical carcinogens, will have restricted access.
C. Signs warning "Authorized Personnel Only" will be posted at entrances to these work areas, and if necessary, these areas will be locked.
D. Only personnel with special instruction on the hazards and safe handling of carcinogens will be permitted access to the areas.
E. The rooms where carcinogens are used and stored should be kept at a slight negative pressure when compared to the rest of the rooms.

4.3.3 Closed System Protection

All work involving carcinogens must be done in specially equipped closed systems to reduce the risk of employee exposure to the vapors. Closed systems include fume hoods, glove boxes or similar devices.

4.3.4 Handling of Contaminated Waste

Rinse-water and other waste waters contaminated with carcinogens are to be collected and labeled for disposal.

4.3.5 Personal Hygiene

Laboratory workers using carcinogens shall take extra precautions in maintaining good personal hygiene. Refer to good hygiene practices in Section 4.1.4.

4.3.6 Protection of Vacuum Systems

To protect vacuum lines and pumps, HEPA filters or High Efficiency Scrubber systems should be used if carcinogens are present.

4.3.7 Personal Protective Equipment

A. Any person working in restricted areas should not wear any personal items which might be lost if decontamination is not possible.
B. Disposable clothing should be used whenever possible.
C. Gloves and long sleeves should be used at all times to prevent skin contact.
D. Use appropriate eye protection such as safety glasses, goggles, and face shields.
E. Hair should be secured to prevent contamination.

4.3.8 Additional Precautions

Work with carcinogens should be performed with the smallest quantities possible. This will decrease disposal costs, storage problems, and minimize risks.

4.4 General Control Measures and Equipment

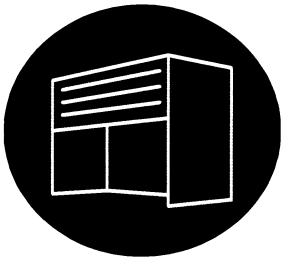
Chemical safety is accomplished through an awareness of the chemical hazards and by keeping the chemical under control through a variety of engineered safeguards. Laboratory personnel should be familiar with the proper use of all safeguards.

A. Laboratory supervisors and employees should be able to detect the malfunction of all safeguards.
B. All engineering controls must be properly maintained, inspected on a regular basis, and used within their design limits.

4.4.1 Fume Hoods

Work done with chemicals with low PELs or high vapor pressures should be done in a fume hood. The fume hood should provide 100 to 150 linear feet per minute of air flow at the face of the hood at a 12 inch sash height. When using a fume hood, the worker should be aware of the following:

A. Sashes should be at most 12 inches from the base at all times except when adjusting the apparatus inside.
B. Equipment inside the hood should be kept towards the rear of the hood to prevent vapors from escaping.
C. **Hoods are not storage areas.**
D. The vent ducts and fans must be kept clean and clear of obstructions.
E. The hood must remain "on" at all times when a chemical is inside the hood.
F. Personnel should be aware of emergency response procedures in the event of a hood failure.
G. Inspections are performed periodically to assure proper hood function.



4.4.2 Bunsen Burners or Open Flames

Open flames in a laboratory must always be avoided. This is especially important when flammables are present. YU prohibits the use of open flames when flammables are being used. Bunsen Burners should not be used in biosafety cabinets since this combination may increase the potential for explosion when flammables are present. If there is a spill of a flammable chemical in the laboratory, all open flames must be extinguished.

4.4.3 Safety Cans

Flammable liquids should be kept in safety cans. These cans should be handled according to manufacturer's instructions and common safety practices.

A. The can must be kept closed except when adding or removing liquid.
B. The flame arrester screen must be kept in place at all times and replaced if punctured or damaged.
C. Chemicals in safety cans must be kept in storage areas and not in laboratory work areas, hallways, or on the floor.
D. All flammables must be protected against sources of ignition.

4.4.4 Flammable Storage Cabinets

Cabinets designed for the safe storage of flammable chemicals can only do so if used and maintained properly. Always read the manufacturer's information and follow prudent safety practices.

A. Store only compatible materials inside the cabinet.
B. 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).
C. Do not store paper or cardboard inside cabinets.
D. Do not overload the cabinet.

4.4.5 Corrosive Storage Cabinets

All corrosive chemicals should be kept in specially designed cabinets. Care must be taken to separate acids from bases by distance or barriers.

4.4.6 Eyewashes and Safety Showers

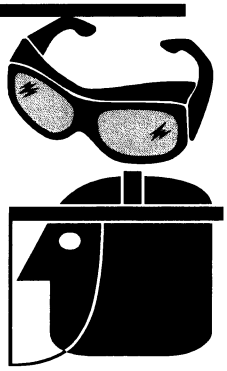
Whenever chemicals have the possibility of damaging the skin or eyes, an emergency supply of water must be available. All laboratories must have access to eyewashes and safety showers, or sink dowsers. **NOTE THE LOCATION OF THE SAFETY EQUIPMENT IN YOUR AREA BEFORE AN EMERGENCY OCCURS.** Be aware of the following:

A. Keep all passageways to the eyewash and shower clear of any obstacles.
B. Eyewashes and Showers should be checked routinely to assure proper flow.

4.4.7 Personal Protective Equipment (PPE)

For more information on PPE please refer to the YU/Einstein's "Personal Protective Equipment Guidelines."

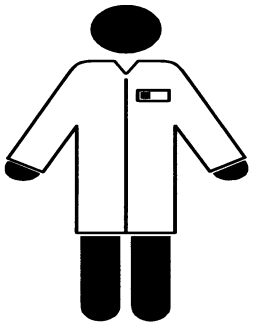
A. Gloves - Must be of a material compatible with the chemicals used. Gloves should be inflated (by whipping it in air, not by mouth inflation) to check its integrity before each use. See Appendix D "Choosing the Right Glove".



B. Safety glasses - Should only be used when working with solid materials. Glasses should not be used with liquid chemicals.

C. Goggles and Face Shield - Must be used when working with hazardous chemicals, corrosives, and hot chemicals. The goggles protect the eyes in case of a splash from the side or beneath the shield.

D. Laboratory Coat - Long sleeved coats offer the wearer minimal skin protection against minor splashes.



E. Laboratory Coat and Apron - Rubberized aprons offer additional protection from splashes. Arm guards should be worn when using an apron.

F. Street clothing such as long sleeved shirts, pants, and closed shoes are also important components to personal protective equipment.

4.4.8 Respirators

Respirators are required if the levels of a contaminant in the air exceeds the OSHA permissible exposure limit (PEL). If administrative and engineering controls are inadequate to maintain the concentration below these levels, the employer will implement YU's/Einstein's Respiratory Protection Program in accordance with 29 CFR 1910.134. The written respirator program discusses such issues as respirator selection, inspection, maintenance, and proper fit. All personnel using respirators must be trained in the proper use and care of a respirator. Medical surveillance is also required. For more detailed discussion of respirator use and selection, see YU's/AECOM's "Respiratory Protection Program", Appendix E.

4.4.9 Odor Detection

If suspicious odors are noticed, the investigators should contact EH&S for assistance.

4.5 Emergency Procedures

4.5.1 Spills and Accidents

A. Spills of toxic substances or accidents involving any hazardous chemical should be resolved immediately, according to YU's/Einstein's written Emergency and Contingency Plan, attached as Appendix C. The overall steps of handling an accident are as follows:

a. Notify your Principal Investigator/Supervisor and EH&S at (212) 923-0784 for YU or (718) 430-4150 for Einstein.

b. If spilled chemical is flammable, eliminate all nearby sources of ignition.

c. If a person has been splashed with a chemical, wash the affected area with water for at least 15 minutes, remove all contaminated clothing and seek medical attention immediately.

B. There are some fundamental actions which must NOT be used in handling emergencies. Some of them include:

a. DO NOT force any liquids into the mouth of an unconscious person.

b. DO NOT handle emergencies alone, especially without notifying someone that the accident has occurred.

c. DO NOT apply medical aid procedures without training in that area. If you are not trained in first aid, get medical direction before proceeding.

d. DO NOT linger at the accident scene if you are not one of the emergency responders.

4.5.2 Fire Emergencies

A. If you <u>smell</u> smoke

a. At YU Call Security at (212) 960-5200 (or X200) and EH&S at (212) 923-0784. AT Einstein dial 4111 or EH&S at (718) 430-4150.

B. If you <u>see</u> smoke or fire

a. Activate nearest fire alarm and call Security at YU and 4111 at Einstein.
Advise the operator of the specific location of the fire.

b. Alert coworkers and remove any incapacitated person who may be in danger.
c. If possible, close windows and doors to fire area.
d. If the fire is small and controllable, you can attempt to confine and extinguish it with one of the available extinguishers. If you feel the fire is beyond your capacity, do not attempt to extinguish it. Close the door to the room or area involved.
e. Evacuate floor via stairs.

5 CRITERIA FOR CONTROL MEASURES

This section examines criteria and guidelines to determine whether the use of engineering controls and personal protective equipment are needed.

5.1 Exposure Guidelines

All hazardous chemicals must be used in an operating fume hood. The following parameters can be used to determine the proper safety precautions such as engineering controls or the need for respiratory protection:

A. Threshold Limits Values (TLV) or Permissible Exposure Limits (PEL).
B. Lethal Dosage (LD) information.
C. Vapor pressure.

5.2 Fire Guidelines

The following parameters will be used to determine the proper fire safety precautions:

A. Flash point - The lowest temperature at which an ignition source can cause the chemical vapor to ignite.
B. Flammable - Any chemical with a flash point below 100 degrees Fahrenheit (F).
C. Combustible - Any chemical with a flash point between 100 degrees Fahrenheit (F) and 140° F.

A detailed discussion of fire hazards can be found in OSHA's regulations 29 Code of Federal Regulations 1910 and the New York City Fire Code. Contact Einstein's Fire Safety Officer at (718) 430-2031 for additional information.

5.3 Reactivity Guidelines

Once a chemical has been determined to be reactive, all proper safety precautions will be used including extra segregation in storage and prohibition on mixing with other chemicals without appropriate personal protection and precautions. At YU, a reactive chemical is any one of the following:

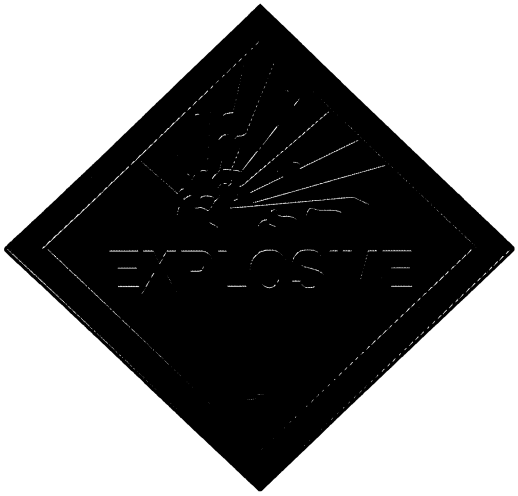
A. Ranked by the National Fire Protection Association (NFPA) as a three (3) or four (4) for reactivity.

B. Determined by the U.S. D.O.T. as either:
   a. an oxidizer.
   b. an organic peroxide.
   c. an explosive (Classes A, B, or C).

C. Fits the U.S. EPA definition of reactive in 40 CFR 261.

D. Fits the OSHA definitions of unstable, or polymerizable.

E. Is found to be reactive with ordinary substances.



CORROSIVE

5.4 Guidelines for work with Corrosives

YU will consider a chemical corrosive if it fits the definition of corrosive found in any of the following regulations:

A. OSHA (29 CFR) - Any chemical that causes visible destruction of, or irreversible alteration in, living tissue by chemical action at the site of contact.

B. DOT (49 CFR) - Any chemical which destroys or changes, irreversibly, the structure of the tissue at the site of contact following an exposure period of four hours.

C. Any aqueous solution that has a pH less than or equal to 2 or greater than or equal to 12.5.

6 EXPOSURE EVALUATIONS AND MEDICAL CONSULTATIONS

6.1 Suspected Exposures to Toxic Substances

When an employee suspects that he/she has been exposed to a toxic substance in the laboratory, it must be immediately reported to the area supervisor and EH&S. YU will investigate all reasonable suspicions or complaints regarding possible chemical exposure.

6.1.1 Examples of Suspicions of Exposure

There are many signs that a chemical exposure may have taken place. The following list includes only a few examples of these signs.

A. Victim has had direct body, skin, or eye contact with a chemical substance.
B. Chemical odor is detected while there is nearby work with a hazardous chemical.
C. Symptoms of headache, rash, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgement which resembles drunkenness occur.
D. Some or all symptoms disappear when the person is taken away from chemical area and into fresh air. Previous symptoms reappear soon after a person starts working with the same chemicals.
E. Complaints are received from more than one person in the same work area.

It is YU's policy to promptly investigate all complaints to determine risk of employee exposure to toxic substances in the workplace.

6.2 Exposure Evaluations

When a complaint of possible hazardous chemical exposure has been received, it should be documented in a short memorandum or incident report along with the decision of appropriate action. If it was decided that no further evaluation of the event is necessary, the reason for that decision should be included in the document. If a decision is made that the complaint should be investigated further, then a formal Exposure Evaluation will commence.

6.2.1 Steps of Exposure Evaluation

Exposure evaluation will be determined by EH&S. The purpose of the exposure evaluation is to determine if any exposure has taken place, not to assign blame. The steps in the Exposure Evaluation process include, but are not limited to:

A. Interviewing the affected individuals.

B. Listing essential information about the circumstances of the complaint including:
   a. Chemicals in question.
   b. Other chemicals being used or stored in the immediate area.
   c. Relevant health symptoms.
   d. Use of administrative, engineering, and personal protective control measures.

C. Determining appropriate action through:
   a. Air sampling of the area for suspect chemicals.
   b. Determining how the symptoms compare to the information on the Material Safety Data Sheet.
   c. Deciding whether to send victim for medical evaluation.
   d. Reviewing of the adequacies of present control measures and safety procedures.

D. As the need requires, we may call in an outside consulting firm to assist in the exposure evaluation.

E. The employees will be notified of the results of the evaluation within a reasonable period of time.

6.3 Medical Consultation and Examinations

A. YU will provide any employee who works with hazardous chemicals the opportunity to receive emergency medical attention including any physician directed follow-up examinations under the following conditions.
   a. The employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
   b. Exposure monitoring reveals levels of a regulated substance above the action level or PEL.
   c. An event such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure.

B. All medical evaluations will be provided without cost to the employee.

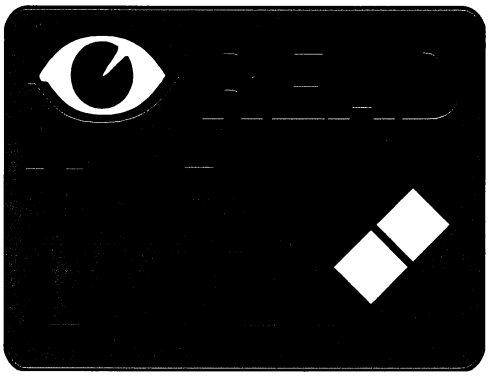
C. All appropriate information will be provided to the physician.

D. The physician will provide a written evaluation to the employer. This information shall not reveal any findings unrelated to occupational exposure. It shall include the following items:
   a. Any recommendations for further medical follow-up.
   b. The results of the examination.

c. Any medical condition which may pose an increased risk to the employee as a result of the hazardous chemicals found in the work place.
d. A statement that the employee has been informed of all of the appropriate findings of the examination.

6.4 Documentation

All memos, notes, and reports related to a complaint of possible exposure to toxic substances must be maintained in a file for easy retrieval with a cross-reference in the victim's file. For more on reports and record keeping, see Section 8.



7. EMPLOYEE INFORMATION AND TRAINING

7.1 Information Requirements

OSHA has required that employees be informed of:

A. The existence, location, and availability of the Chemical Hygiene Plan.
B. 29 CFR 1910.1450, and its appendices.
C. The criteria to select and use personal protective equipment.
D. The availability of exposure limit information, including TLVs and PELs.
E. The emergency procedures and the location of safety equipment.
F. The location of reference material including Material Safety Data Sheets.

7.1.1 Dissemination of Information

YU uses many methods to distribute information to its employees including:

A. Formal training.
B. Informal discussion groups.
C. Individual discussions with supervisors.
D. Posted notices.
E. Handout booklets.
F. Web site (http://www.einstein.yu.edu/ehs).
G. MSDS web site.

7.2 Training Under 29 CFR 1910.1450

Training under 29 CFR 1910.1450 must include the following:

H. Methods and observations used to detect the presence or release of hazardous chemicals such as:
   a. Monitoring conducted by the employer.
   b. Continuous monitoring devices.
   c. Visual appearance or odor of hazardous chemicals.

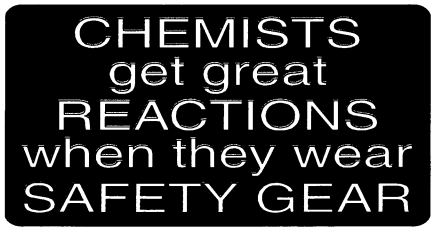
I. The physical and health hazards of chemicals in the work area.

J. YU policies implemented to protect employees from exposure to hazardous chemicals.
   a. Appropriate work practices.
   b. Emergency procedures.
   c. Personal protective equipment.

K. Details of YU's/Einstein's written Chemical Hygiene Plan.

7.3 Evaluating the Training's Effectiveness

The training program will be evaluated periodically to determine its effectiveness and improvements will be made if necessary.



8. RECORDS AND RECORD KEEPING

8.1 Records

A. In the event of lost work time resulting from an exposure or accident on the job, the OSHA 200 form is used to document lost workdays from incidents that occur at work.

B. YU maintains various records pertaining to employee safety including:
   a. Employees exposure complaints.
   b. Exposure evaluation results and reports.
   c. Control system records.
   d. Accident/injury reports.
   e. Training records.
   f. Hazardous waste records.
   g. Medical records.

8.2 Recordkeeping

Because many diseases will not manifest symptoms for an extended amount of time, it is important to keep medical records to ensure accurate accounting of employee exposures. Most medical records are kept for 30 years after the end of employment. Exceptions can be found in the general safety and health provisions of 29 CFR 1910.20 under "Access to employee exposure and medical records".

Every employee has the right to access their medical records. These records can be obtained by contacting Occupational Health Services.

9. EVALUATING THE CHEMICAL HYGIENE PROGRAM'S EFFECTIVENESS

To ensure that the chemical hygiene program is accomplishing its stated goals, several reviews shall be undertaken on periodic intervals including:

A. Documentation of training.
B. Initial and refresher training tests.
C. Laboratory inspections.
D. Review and update the written plan.
E. Work place contaminant monitoring.
F. Communicating with the YU laboratory community.
G. Participating in various safety committees.

10. SUMMARY OF OSHA's LABORATORY STANDARD

10.1 Scope and Application

A. Applies to all employers whose laboratories use hazardous chemicals.
B. 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:
   a. Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
   b. For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories.

c. Where the action level or the PEL is routinely exceeded for an OSHA regulated substance, the monitoring and medical surveillance sections of the standard will apply.

10.2 Definitions

All definitions can be found in Appendix J of this document.

10.3 Permissible Exposure Limits

YU will ensure that exposures to regulated substances do not exceed the PELs.

10.4 Employee Exposure Determination

Background monitoring for contaminants will be performed as needed to assure that levels remain below recommended standards. If there is reason to believe that these levels routinely exceed the action level for an OSHA designated chemical, the following monitoring schedule will apply:

A. Initial Monitoring - The employer shall measure an employee's exposure to any substance regulated by a standard which requires monitoring.
B. Periodic Monitoring - If initial monitoring indicates employee exposure above the PEL or action level, the employer shall immediately comply with the monitoring provisions of the relevant standard.
C. Termination of Monitoring - The employer may terminate monitoring in accordance with the relevant standard.
D. Notification - The employee must be notified of the results of the monitoring within 15 days of the employer's receipt of the results.

10.5 Chemical Hygiene Plan

A. Where hazardous chemicals are used in the workplace, the employer shall develop and carry out the provisions of a Chemical Hygiene Plan, the goal of which is:
   a. To protect employees from health hazards associated with hazardous chemicals in that laboratory.
   b. To keep the exposures below the action level or PEL.
B. The Chemical Hygiene Plan must be readily accessible to employees.
C. The Chemical Hygiene Plan shall include each of the following elements:
   a. Specific measures the employer will take to ensure laboratory employee protection.
   b. Standard operating procedures relevant to safety and health.
   c. Criteria which the employer will use to reduce employee exposure to hazardous chemicals.
   d. A provision that fume hoods and other protective equipment function properly.
   e. Methods to ensure proper and adequate performance of the equipment.
   f. Provisions for employee training and information.
   g. Circumstances requiring prior approval from the employer or his designee before implementation.
   h. Provisions for medical consultation and examination.
   i. Designation of personnel responsible for implementation of the Chemical Hygiene Plan.

j. Provisions for additional protection for employees working with particularly hazardous substances including select carcinogens, reproductive toxins, and substances with high degree of acute toxicity. Specific consideration shall be given to the following, where appropriate:
   i establishment of a designated area.
   ii use of containment devices such as fume hoods or glove boxes.
   iii procedures for safe removal of contaminated waste.
   iv decontamination procedures.

D. The employer shall review and update the plan at least annually.

10.6 Employee Information and Training

A. The employer shall provide employees with information and training to ensure that they are informed of the hazards of chemicals in their work area.

B. Information and training shall be provided at the time of an employee's initial assignment where hazardous chemicals are present, and prior to assignments involving new exposure hazards.

C. Information will be made available concerning:
   a. The contents of this standard and its appendices.
   b. The location and availability of the Chemical Hygiene Plan.
   c. The PELs for OSHA-regulated substances or Recommended Exposure Limits for other hazardous chemicals where PELs do not exist.
   d. Signs and symptoms associated with exposures to the hazardous chemicals used in the laboratory.
   e. The location and availability of known reference materials including MSDSs.

D. Training - employee training shall include:
   a. Methods and observations to detect the presence or release of hazardous chemicals.
   b. The physical and health hazards of chemicals in the work place.
   c. Hazard avoidance measures such as:
      i appropriate work practices.
      ii emergency procedures.
      iii personal protective equipment.

10.7 Medical Consultation and Medical Examinations

A. The employer shall provide all employees who work with hazardous chemicals an opportunity to receive emergency medical attention under the following circumstances.
   a. The employee develops signs or symptoms associated with a hazardous chemical exposure.
   b. Monitoring reveals exposure routinely above the PEL or action level.
   c. 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.

B. All medical examinations and consultations shall be performed by a licensed physician or under his/her direct supervision.

C. The employer shall provide the following information to the physician:

a. The identity of the hazardous chemicals to which the employee may have been exposed.
b. A description of the conditions under which the exposure occurred.
c. A description of any signs and symptoms of exposure employee is experiencing.

D. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure. The physician's written opinion should include:
a. Any recommendation for further medical follow-up.
b. The results of the examination and any associated tests.
c. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk.
d. A statement that the employee has been informed by the physician of the results of the examination and any medical condition that may require further examination or treatment.

10.8 Hazard Identification

A. Labels and Material Safety Data Sheets - employers shall:
a. Ensure that labels on incoming hazardous chemicals are not removed or defaced.
b. Maintain all MSDSs received and make them available to employees. Recently, OSHA has accepted electronic files of MSDSs as suitable to meet its requirements.

B. The following provisions shall apply to chemical substances developed in the lab:
a. If the composition of a chemical substance produced for laboratory use is known and determined to be hazardous, the employer shall supply appropriate training.
b. If the chemical produced is a by-product whose composition is not known, the employer shall assume that it is hazardous and implement the Chemical Hygiene Plan.
c. If the chemical substance is produced for a user outside of the laboratory, the employer shall comply with the Hazard Communication Standard, 29 CFR 1910.1200, including the requirements for the preparation of a Material Safety Date Sheet and labeling.

10.9 Use of Respirators

Where the use of respirators is required to maintain exposure below the PEL, the employer shall provide the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134. See YU's/Einstein's Respiratory Protection Plan, Appendix E.

10.10 Recordkeeping

A. 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.

B. The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

APPENDIXES

A. Subpart 191.1450, Occupational Exposure to Hazardous Chemicals in Laboratories.
B. List of Carcinogens at Yeshiva and Albert Einstein College of Medicine.
   I. Known and Probable Carcinogens, I.A.R.C.
   II. Potential Carcinogens, I.A.R.C.
C. Albert Einstein College of Medicine, Emergency Contingency Plan.
D. Choosing the Right Protective Glove.
E. Yeshiva University and Albert Einstein College of Medicine, Respiratory Protection Program
F. Statement of Medical Services.
G. List and Locations of References and Material Safety Data Sheets.
H. Partial List of Known Hazards of and Specific Precautions for a Selected Group of Laboratory Chemicals.
I. Emergency Telephone Numbers.
J. Glossary of Terms.
K. Site Map of Yeshiva University and Albert Einstein College of Medicine Campus.
L. Department of Environmental Health and Safety Miscellaneous Forms.
M. Einstein EH&S Evaluation Form for Grant Applications and Research Involving Hazardous Materials.

APPENDIX A

SUBPART 191.1450

OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

APPENDIX A

SUBPART 191.1450

OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for part 1910, subpart Z is amended by adding the following citation at the end. (Citation which precedes asterisk indicates general rulemaking authority.)

Authority: Secs. 6 and 8, Occupational Safety and Health Act, 29 U.S.C. 655, 657; Secretary of Labor's Orders Nos. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable; and 29 CFR part 1911. * * * Section 1910.1450 is also issued under sec. 6(b), 8(c) and 8(g)(2), Pub. L. 91–596, 84 Stat. 1593, 1599, 1600; 29 U.S.C. 655, 657.

2. Section 1910.1450 is added to subpart Z, part 1910 to read as follows:

§ 191.1450 Occupational exposure to hazardous chemicals in laboratories.

(a) *Scope and application.* (1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(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:

(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.

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

(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.

(3) This section shall not apply to:

(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 2, even if such use occurs in a laboratory.

(ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

(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

(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.

(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 °F (37.8 °C), but below 200 °F (93.3 °C), except any mixture having components with flashpoints of 200 °F (93.3 °C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"*Compressed gas*" means:

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

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

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

"*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 °F (37.8 °C), except any mixture having components with flashpoints of 100 °F (37.8 °C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

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

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

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

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

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

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

"*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 safely 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 moveable 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 that 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 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/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.

"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.

(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.

(d) *Employee exposure determination*—(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).

(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.

(3) *Termination of monitoring.* Monitoring may be terminated in accordance with the relevant standard.

(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.

(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.) (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:

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

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

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

(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:

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

(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;

(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;

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

(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;

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

(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

(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:

(A) Establishment of a designated area;

(B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and

(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) *Employee information and training.* (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.

(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.

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

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(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.

(4) *Training.* (i) Employee training shall include:

(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.);

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

(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.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) *Medical consultation and medical examinations.* (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:

(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.

(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.

(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.

(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.

(3) *Information provided to the physician.* The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) *Physician's written opinion.* (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:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(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 chemical found in the workplace; and

(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.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) *Hazard identification.* (1) With respect to labels and material safety data sheets:

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

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

(2) The following provisions shall apply to chemical substances developed in the laboratory:

(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.

(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.

(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.

(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.

(j) *Recordkeeping.* (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.

(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.

(k) *Dates*—(1) *Effective date.* This section shall become effective May 1, 1990.

(2) *Start-up dates.* (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

(ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(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.

APPENDIX B

LIST of CARCINOGENS USED at YESHIVA UNIVERSITY

I. KNOWN and PROBABLE CARCINOGENS, I.A.R.C.
II. POTENTIAL CARCINOGENS, I.A.R.C.

APPENDIX B

LIST of CARCINOGENS USED at YESHIVA UNIVERSITY

I. KNOWN and PROBABLE CARCINOGENS*

*Based on National Toxicology Program and International Agency for Research on Cancer (IARC) Classifications.

Known

4-Aminobiphenyl
Analgesic Mixtures Containing Phenacetin
Arsenic
Arsenic Pentoxide
Arsenic Powder
Arsenic Trichloride
Arsenic Trioxide
Asbestos
Azathioprine
Benzene
Benzidine
Bis (chloromethyl) ether and Technical Grade Methyl Ether
1,4-Butanediol Dimethylsulfonate (Myleran)
Chlorambucil
Chromium Powder
Chromium (IV) Oxide
Conjugated Estrogens
Cyclophosphamide
Diethylstilbestrol
Lead Arsenate
Melphalan
Methoxsalen with Ultra-violet A Therapy (PUVA)
Mustard Gas
2-Naphthylamine
Sodium Arsenate
Sodium Arsenite
Thorium Dioxide
Vinyl Chloride

Probable

Acrylonitrile
Cadmium Chloride
Cadmium Powder
Cadmium Sulfate
Carbon Tetrachloride
Chloroform
Ethylene Oxide
Nickel Powder
O-Toluidine

APPENDIX B - (cont'd)

II. POTENTIAL CARCINOGENS*

*Based on National Toxicology Program and International Agency for Research on Cancer (IARC) classifications.

Acetamide
2-Acetylaminofluorne
Adriamycin-
Aflatoxins
1-Amino -2-methylanthraquinone
2-Aminoanthraquinone
o-Aminoazotoluene
Amitrole
Aniline (or any of its salts)
o-Anisidine Hydrochloride
Benz (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (j) floranthene
Benzo (k) fluoranthene
Dibenzo (a,e) acridine
Dibenzo (a,h) pyrene
Dibenzo (a,i) pyrene
Indeno (1,2,3-cd) pyrene
2-Methylaziridine (Propyleneinine)
Benzotrichloride
Beryllium
Beryllium Carbonate
Bischloroethyl Nitrosourea
1,3-Butadiene
C.I. Basic Red 9 Monohydro-chloride
Chlorendic Acid
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
3-Chloro-2-methylpropene
4-Chloro-o-phenylenediamine
Chlorinated Paraffins (C12 60% Chlorine)
p-Cresidine
Cupferron
1,4-Dioxane (p-Dioxane)
Dacarbazine
2,4-Deaminotoluene
DDT
Di(2-ethylhexyl) phthalate
2,4-Diaminoanisole Sulfate
1,2-Dibromo-3-chloropropane
1,2-Dibromethane (EDB)
3,3'-Dichlorobenzidine and 3,3'-Dichloro-Benzidine Dihydrochloride
1,4-Dichlorobenzene
1,2-Dichlorobenzene
Dichloromethant (Methylene Chloride)
1,3-Dichloropropene (Technical Grade)
Diepoxybutane
Diethyl Sulfate
Diglycidyl Resorcinol Ether
3,3'-Dimethylbenzidine
Dimethyl Sulfate
4-Dimethylaminoazobenzene
3,3'-Dimethylbenzidine
Dimethylcarbamyol Chloride
1,1-Dimethylhydrazine
Dimethylvinyl Chloride
Direct Black 38
Direct Blue 6
Epichlorohydrin
Estrogens (Not Conjugated): Estrone
Estrogens (Not Conjugated): Mestranol Ethyl Acrylate
Estrogens (Not Conjugated): Nitrilotriaecetic Acid
Estrogens (Not Conjugated): Estradiol -17B
Ethinylestradiol
Ethylene Thiourea
Hexachlorobenzene
Hexamethylphosphoramide
Hydrazine & Hydraqzine Sulfate
Hydrazobenzene
Iron Dextran Complex
Kepone (Chlordecone)
Lead Acetate
Lead Diacetate
Lead Phosphate
Lindane and Other Hexachlorocyclohexane Isomers
Metronidazole
Michler's Ketone

APPENDIX B - (cont'd)

Mirex
2-Nitropropane
5-Nitro-o-anisidine
N-Nitroso-N-ethylurea
N-Nitroso-N-methylurea
N-Nitrosodi-n-butylamine
N-Nitrosodi-n-propylamine
N-Nitrosodiethanolamine
N-Nitrosodimethylamine
N-Nitrosomethylvinylamine
N-Nitrosomorpholine
N-Nitrosonornicotine
P-Nitrosodiphenylamine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
N-Nitrososarcosine
Nickel
Nickel (II) Acetate
Nitrofen
Nitrogen Mustard Hydrochloride
Norethisterone
4,4'-Oxydiniline
Oxymetholone
Phenacetin
Phenazopyridine Hydrochloride
Phenoxybenzamine Hydrochloride
Phenytoin
Polybromated Biphenyls
Polyclorinated Bipheryls
Polycyclic Aromatic Hydrocarbons,
1,3-Propane Sultone
b-Propiolactone
5-Methylchrysene
4,4'-Methylenebis (2-chloroaniline)
(MBOCA)
4,4'Methylenebis (N,N-dimethyl)
benzenamine
4,4'-Methylenedianiline and its Dihydrochloride
Procarbazine Hydrochloride
Progesterone
Propylene Oxide
Propylthiouracil
Reserpine
Saccharin
Safrole
Selenium Sulfide
Streptozotocin
Sulfallate
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
Tetrachloroethylene (Perchloroethylene)
Thioacetamide
Thiourea
Toluene Diisocyanate
Toxaphene
2,4,6-Trichlorophenol
Tris (2,3,-dibromopropyl) phosphate
Tris (1-aziridinyl) Phosphine Sulfide
Urethane (Ethyl Carbamate)

APPENDIX C

EMERGENCY CONTINGENCY PLAN

APPENDIX C

EMERGENCY CONTINGENCY PLAN

I. Response to Chemical Spills:

The following sequence of events should be initiated when a potentially-hazardous chemical is spilled in a laboratory:

1. Notify your supervisor and call Security at YU and X4111 at Einstein, to report the spill.

2. If spilled chemical is flammable, extinguish all nearby sources of ignition.

3. If a person has been splashed with a chemical, wash them with copious amounts of water for at least 15 minutes, remove all contaminated clothing, and GET MEDICAL ATTENTION. Employees at Einstein will be seen at the Employee Health Service, 1894 Eastchester Road, 2nd floor (718) 794-7048 or at Jacobi or Weiler Hospital's Emergency Room, depending on the situation. See Appendix K for a site map of the Einstein Campus.
At Yeshiva University, call 911. The ambulance or Hatzolah will transport the person to the nearest hospital or treatment center.

4. If a person has been overexposed by inhalation, get victim to fresh air, if you are certified and, if necessary, apply artificial respiration, and GET MEDICAL ATTENTION. Employees will be seen at the Employee Health Service, 1894 Eastchester Road, 2nd floor (718) 794-7048 or at Jacobi or Weiler Hospital's Emergency Room, depending on the situation.
At Yeshiva University, call 911. The ambulance or Hatzolah will transport the person to the nearest hospital or treatment center.

5. In other cases of overexposure, GET MEDICAL ATTENTION and follow the instructions of the medical professional. Employees at Einstein will be seen at the Employee Health Service, 1894 Eastchester Road, 2nd floor (718) 794-7048 or at Jacobi or Weiler Hospital's Emergency Room, depending on the situation.
At Yeshiva University, call 911. The ambulance or Hatzolah will transport the person to the nearest hospital or treatment center.

6. After securing proper medical attention for a chemical exposure victim, do not worry about neutralizing the spill. Simply prevent its spread if possible. At Einstein call EH&S at X4150 or Security at 4111.

   At Yeshiva University, call (212) 960-5200 for the Wilf Campus; (212) 340-7717 for the Beren Campus; (212) 790-0200 or (212) 790-0303 for the Brookdale Center.

7. Identify the spill (i.e., name of chemical involved, approximate quantity).

APPENDIX C (cont'd)

8. Evacuate the area, leave the ventilation on, and close the doors. If you require EH&S to clean up the spill, then the room must be evacuated.

9. The Department of Environmental Health and Safety shall:
   A. Produce the proper Material Safety Data Sheet.
      - determine the hazards associated with the spilled chemical.
      - select the proper personal protective equipment.
      - select the proper chemical response material.
   B. Go to the location with a minimum of two people, a mobile phone, and the spill cart if required.
   C. Devise plan for the clean up and decontamination.
   D. Assist the laboratory personnel with clean up or clean up the spill if it is a large spill.
   E. Determine when the area may be re-occupied.
   F. Write up an incident report including corrective action to be taken in the future.

APPENDIX D

CHOOSING THE RIGHT PROTECTIVE GLOVE

APPENDIX D

This table shows the relative resistance ratings of various glove materials to some industrial solutions. **NOTE:** The purpose of gloves is to eliminate or reduce skin exposure to chemical substances. NEVER IMMERSE the hands, even with gloves rated E (excellent).

KEY TO CHARTS: E = excellent; G = good; F = fair; P = poor (Ratings are subject to variation, depending on formulation, thickness, and whether the material is supported by fabric).

The listings were taken from various glove manufacturers and NIOSH, and are ONLY A GENERAL GUIDE. When selecting gloves for any application, contact the manufacturer, giving as much detailed information as possible, according to the following:

1. Ability of glove to resist penetration of the chemical, thus ensuring the protection of the wearer
2. Chemical composition of the solution
3. Degree of concentration
4. Abrasive effects of materials being handled
5. Temperature conditions
6. Time cycle of use
7. Specify in purchase order what materials are to be handled
8. Cost

Chemical Resistance Chart

Glove Material	*mineral acids*	*organic acids*	*caustics*	*alcohols*	*aromatic solvents*	*petroleum solvents*	*ketonic solvents*	*chlorinated solvents*
	Hydrochloric (38%)	*Acetic*	*Sodium Hydroxide (50%)*	*Methanol*	*Toluene*	*Naphtha*	*Methyl Ethyl Ketone*	*Perchlor-ethylene*
Natural Rubber	G	E	E	E	NR	F	E	NR
Neoprene	E	E	E	E	F	E	G	P
Polyvinyl Chloride	G	G	G	G	P	F	NR	NR
Polyvinyl Alcohol	P	NR	NR	F	E	E	F	E
NBR	E	G	E	G	G	E	F	G

Miscellaneous

Glove Material	*Lacquer Thinner*	*Benzene*	*Formaldehyde*	*Ethyl Acetate*	*Vegetable Oils*	*Animal Fats*	*Turpentine*	*Phenol*
Natural Rubber	F	NR	E	F	F	P	F	F
Neoprene	G	P	E	G	G	E	G	E
Polyvinyl Chloride	F	P	E	P	F	G	G	G
Polyvinyl Alcohol	E	E	P	P	E	E	E	F
NBR	G	G	E	G	E	E	E	G

Physical Performance Chart*

Coating	*Abrasion Resistance*	*Cut Resistance*	*Puncture Resistance*	*Heat Resistance*	*Flexibility*	*Ozone Resistance*	*Tear Resistance*	*Relative Cost*
Natural Rubber	E	E	E	F	E	P	E	Medium
Neoprene	E	E	G	G	G	E	G	Medium
Chlorinated Polyethylene (CPE)	E	G	G	G	G	E	G	Low
Butyl Rubber	F	G	G	E	G	E	G	High
Polyvinyl Chloride	G	P	G	P	F	E	G	Low
Polyvinyl Alcohol	F	F	F	G	P	E	G	Very High
Polyethylene	F	F	P	F	G	F	F	Low
Nitrile Rubber	E	E	E	G	E	F	G	Medium
Nitrile Rubber/Polyvinyl Chloride (Nitrile PVC)	G	G	G	F	G	E	G	Medium
Polyurethane	E	G	G	G	E	G	G	High
Styrene-butadiene Rubber (SBR)	E	G	F	G	G	F	F	Low
Viton	G	G	G	G	G	E	G	Very High

*Grip/slip is related to glove surface and is enhanced when the glove surface is rough.
Dexterity/tactility is related to glove thickness and decreases as the glove thickness increases.

APPENDIX E

RESPIRATORY PROTECTION PROGRAM

APPENDIX E

RESPIRATORY PROTECTION PROGRAM

1. Prior to the issuance of a respirator, all employees shall receive a medical exam to determine the employee's physical ability of wearing a respirator. Presently, Yeshiva University and Albert Einstein College of Medicine utilizes the services of Professional Health Services, Havertown, PA. for medical surveillance.

2. Upon the recommendation of the physician, the employee will be trained in the proper use and maintenance of a respirator. The training program will include:
   a. Appropriate selection of a respirator for the specific hazard.
   b. Recognizing the limitations of a respirator.
   c. Understanding the operating principles and maintenance of a respirator.
   d. The importance of a properly fitted respirator.

3. Training will be conducted by the Industrial Hygienist in the Department of Environmental Health and Safety. At the completion of training, a respirator will be issued and a qualitative fit test will be conducted.

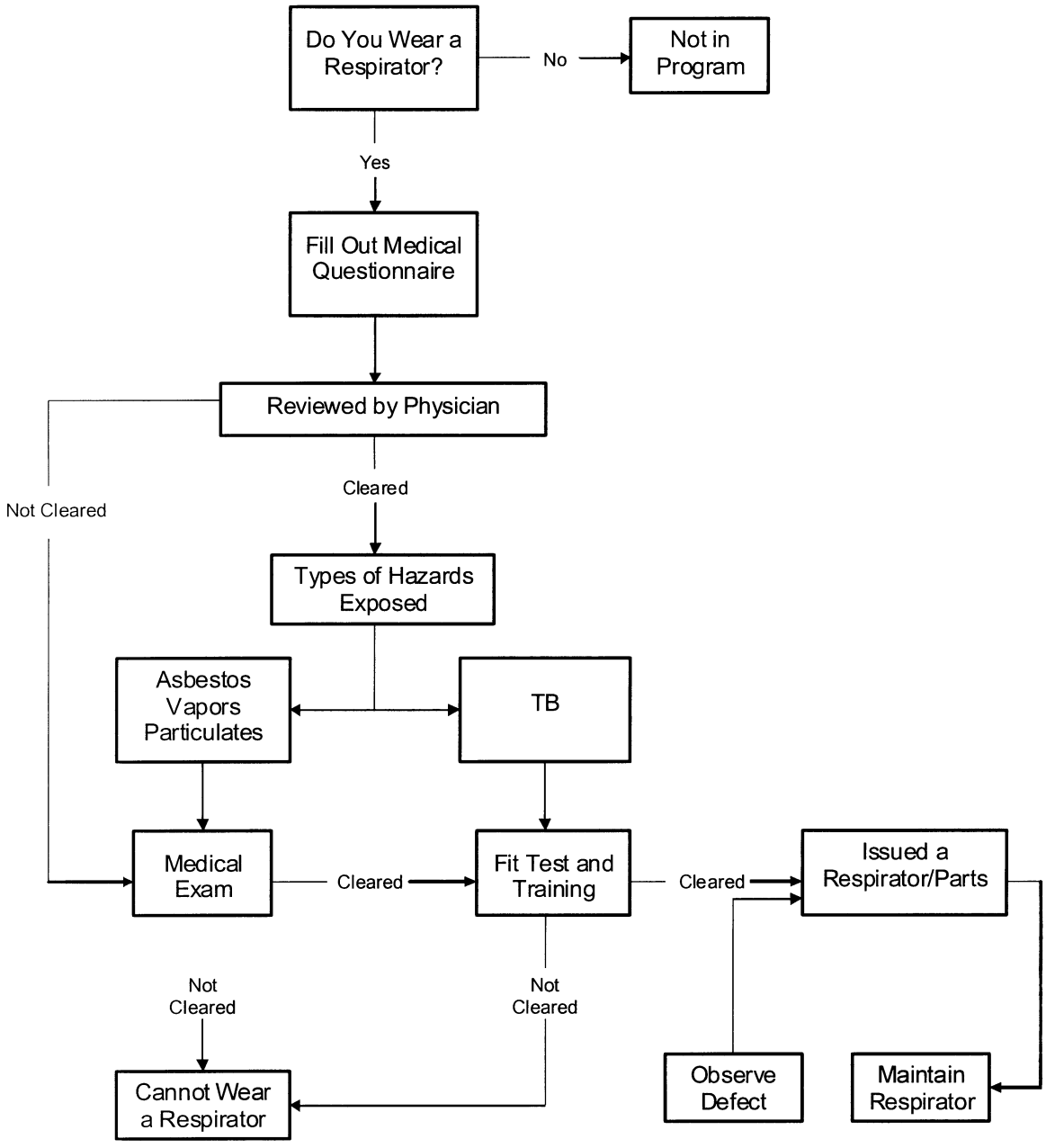
4. The respirator shall be cleaned after every use, regularly disinfected, and stored in a convenient, clean and sanitary location.

5. See attached excerpt from YU's/Einstein's Respiratory Protection Plan.

For more information on Respirators, contact your Supervisor or the Department of Environmental Health and Safety at Einstein at (718) 430-4150 or at YU call (212) 923-0784.

APPENDIX E - RESPIRATORY PROTECTION PROGRAM

RESPIRATORY PROTECTION FLOW CHART



APPENDIX E - RESPIRATORY PROTECTION PROGRAM

I INTRODUCTION:

This program is designed to help reduce employee and Einstein student exposure to occupational air contaminants such as: dust, fumes, mists, gases, vapors, microorganisms, and radionuclides. Where feasible, exposure to contaminants will be eliminated by either engineering controls (i.e., general and local exhaust ventilation, enclosure, or isolation), or substitution of a less hazardous process or material. When effective engineering controls or substitution are not feasible, use of personal protective respiratory equipment may be required. The purpose of this program is to determine the following information:

- When respiratory protection is needed
- Which respirators are needed
- Which employees are required to wear respiratory protection
- How respirators are used in a correct and safe manner.

This program shall be administered pursuant to the requirements of the OSHA Respiratory Protection Standard, 29CFR 1910.134 (Revised April 8, 1998) attached to this document.

II RESPONSIBILITIES:

A. Management:
Yeshiva University is committed to maintaining a healthful and safe work environment. Yeshiva University is responsible for establishing this respiratory protection program to assist in reducing or eliminating workplace exposure to hazardous materials.

B. The Department of Environmental Health and Safety (EH&S):
EH&S is responsible for the management of this program. Specific employees in the Department have responsibilities as follows:

1. Chief Safety Officer, EH&S :
   Program Administrator
2. The YU Safety Specialist and Einstein Industrial Hygienist are charged with the following responsibilities:
   a. Coordination and monitoring of the program.
   b. Evaluation of the need for respirators including surveillance of conditions and degrees of potential exposure.
   c. Modification of the program as appropriate.
   d. Identification of employees for participation in the program.
   e. Establishment/maintenance of medical surveillance.
   f. Coordination of respirator fit testing.
   g. Selection of NIOSH-approved respirators and maintenance of respirator inventory.
   h. Training sessions for participants regarding use, care, and storage of respirators.

i. Communication of changes in regulatory standards and/or the YU/Einstein Respiratory Protection Program to supervisors and employees.
j. Maintenance of records for this program.

C. Supervisors are charged with the responsibility to:

1. Insure that all employees are knowledgeable of the respiratory protection requirements for the areas in which they work.

2. Monitor the proper use and care of respirators.

3. Implement a cleaning and inspection program for respiratory equipment, including designation of proper storage areas for respiratory equipment.

4. Enforce employee compliance with the Respiratory Protection Program.

5. Monitor employee compliance with this program. This includes assurance that:

a. Employees who are required to wear a respirator because of potential exposure, do so, as a condition of employment.
b. Employees participate fully in all aspects of the program including medical surveillance and fit testing before wearing a respirator.
c. Employees follow instructions for use, care, storage, and maintenance as outlined by this program.

D. Employees have the responsibility to:

1. Be aware of respiratory protection requirements for their work area.

2. Follow all aspects of this plan including completion of training, medical surveillance, and fit test requirements, prior to using a respirator.

E. Procurement Services has the responsibility to order only those respirators approved by the program.

F. The Medical Exam contractor has the responsibility to:

1. Evaluate physical ability of employees to wear a respirator.

2. Communicate written results to YU Safety Specialist or Einstein Industrial Hygienist, as appropriate.

G. Fit-Testing contractor is charged with the fit testing of most participants in the Respiratory Protection Program. EH&S performs some additional fit testing as needed including employees working in the Biohazard Facility.

III SELECTION OF RESPIRATORY PROTECTIVE EQUIPMENT:

A. Evaluation of Potential Hazards:

1. Operations and processes will be monitored for potential respiratory hazards, according to accepted industrial hygiene practices.

2. Personal sampling equipment may be used in accordance with accepted industrial hygiene standards to sample an area. Decisions regarding the use of respiratory protection may be based upon these results or by a reasonable and conservative estimate of these hazards.

3. Respirator use is mandatory in areas considered hazardous and will comply with 29 CFR 1910.134 or 1926.110.

4. Voluntary use of respirators is not permitted in areas that are considered non-hazardous at YU and Einstein.

B. Types of respirators:

1. Air-purifying respirators clean the contaminated atmosphere through the use of filters, absorbents, or chemicals. Air-purifying respirators can only be used where there is sufficient oxygen to sustain life and the air contaminant level is within specified limitations of the respirator.

   a. Mechanical-filter, air-purifying respirators provide protection against airborne particulate matter including: dusts, mists, metal fumes, smokes, and microorganisms, but do not provide protection against gases, vapors, or oxygen deficiency.
   b. Chemical-cartridge air-purifying respirators provide protection against certain gases and vapors by using various chemical filters to purify the inhaled air.
   c. The Occupational Safety and Health Administration (OSHA) requires that NIOSH approved air-purifying respirators be used by workers.

2. Atmosphere or air-supplying respirators provide breathable air from a source of air which is independent from the ambient atmosphere. There are three classes of atmosphere-supplying respirators:

   a. Supplied-air respirators
   b. Self-contained breathing apparatuses (SCBA)
   c. Combination-SCBA and supplied-air respirators. The use of SCBA equipment may be required in specific areas for emergency use. Only appropriately trained employees may use SCBA at YU/Einstein.

3. Combination air-purifying and atmosphere-supplying devices have an auxiliary air-purifying attachment, which provides protection in the event the air supply fails.

WORKERS USING RESPIRATORS MUST BE SPECIFICALLY TRAINED FOR THE RESPIRATOR THEY ARE PLANNING TO USE.

C. Respirators currently approved by the Department of Environmental Health and Safety are:

1. Half-face respirator - (3M 6000 and 7500 series)
2. Full-face respirator - (3M 6000 and 7000 series)
3. PAPR respirator - (3M/MASHA)
4. N95 respirator for TB (Tecnol)
5. 3M 8247, 8271, 9210, 9211

D. The following cartridges are available at the EH&S Department. Listed are their part numbers and usage:

1. 2091 - Particulates (dust, mist, fumes, asbestos, and radionuclides)
2. 6001 - Organic Vapor
3. 6002 - Acid Gas
4. 6003 - Organic Vapor/Acid Gas
5. 6004 - Ammonia/Methylamine
6. 6005 - Formaldehyde/Organic Vapor
7. 6006 - Multi Gas/Vapor
8. 6009 - Mercury Vapor or Chlorine
9. Numbers vary (N95) - T.B. Exposure

YU/Einstein shall ensure that all filters, cartridges, and canisters used in the workplace are labeled and color-coded with the NIOSH approval label and that the label is intact and legible.

APPENDIX E - RESPIRATORY PROTECTION PROGRAM

E. Selection of Respirators:

1. Wherever respiratory protection is required, NIOSH-approved respirators, appropriate to the hazards, shall be selected by Einstein EH&S.

2. Selection is based upon physical and chemical properties of air contaminants and concentration levels likely to be encountered by employees.

3. Respirators will be made immediately available to each new hire or transferee to a job where respiratory protection is required.

4. Respirators shall be selected in compliance with all relevant regulatory requirements (29CFR 1910.134 and 29CFR 1926.1101).

F. Areas where respirators may be required:

1. Respiratory protection shall be required in any work area that has the potential to create an environment where the atmospheric contamination levels exceed the OSHA permissible exposure limits (PELs) for the specific contaminant.

2. Respiratory protection shall be required in areas where there is a likelihood of exposure to TB, such as hospitals, healthcare programs and selected clinical research areas.

3. Respiratory protection is always required to be worn in accordance with 29CFR 1926.1101 in any area where workers' tasks may disturb known or potential asbestos-containing material.

4. Self-contained breathing apparatuses may be required to be worn when filtered respirators are not adequate. These may include areas with insufficient oxygen, where contaminants are at a level Immediately Dangerous to Life or Health (IDLH), or the contaminant levels are unknown.

IV MEDICAL EVALUATION:

A. For N95 Respirator users:

1. Prior to the issuance of a respirator all employees shall complete a medical questionnaire. (See 29 CFR 1910.134 Appendix C.) This questionnaire must be approved by a Physician or Licenced Health Care Professional (PLHCP) before issuance of an N95 respirator.

2. Medical examinations will be given to any employee at the discretion of the PLCHP.

B. For Half-Face, Full-Face, PAPR, and SCBA Respirator users:

1. Prior to the issuance of a respirator all employees shall complete a medical questionnaire, (See 29 CFR 1910.134 Appendix C.), and receive a medical exam to determine the employee's physical ability to wear a respirator. This exam shall be provided without cost to each eligible employee.

2. Content of Medical Evaluations:

   a. A complete occupational and medical history update
   b. A complete physical
   c. Pulmonary function testing to include Forced Expiratory Volume at one second (FEVI), Forced Vital Capacity (FVC) and the FEVI -to-FVC ratio.
   d. Chest X-ray and GI evaluation for asbestos workers at the discretion of the PLHCP
   e. Any other test deemed medically appropriate by the examining PLHCP

FIT TESTING:

A. The proper fit of respiratory equipment to the user is determined by a qualitative fit test procedure according to 29 CFR 1910.134 Appendix A.

B. Employees who take part in this program are not permitted to wear beards unless they provide:

1. A documented religious reason

2. A documented medical condition

Employees must provide EH&S with a written personal statement for a religious exemption and a written physician's statement for a medical exemption. Respiratory protection for these employees will be evaluated on a case-by-case basis.

C. Fit testing shall be performed according to the following schedule:

1. Prior to issuance of a respirator, but after medical clearance.

2. Annually for both Asbestos and Non-Asbestos workers and those requiring protection against TB.

APPENDIX E - RESPIRATORY PROTECTION PROGRAM

3. If any of the following conditions occur:

    a. Significant weight gain or loss
    b. Dental changes
    c. Facial scarring
    d. Cosmetic surgery

D. Employees are responsible to check their respirators for fit prior to each use by performing negative and positive seal checks as described in 29 CFR 1910.134 Appendix B-1. If these checks are not successful, the respirator should not be used.

VI RESPIRATOR USE:

A. Employees must be medically cleared to wear a respirator and pass the fit test procedure in order to wear a respirator.

B. Employees may not wear a respirator if they have facial hair which comes between the sealing surface of the face piece and the face or any condition which interferes with the face to face piece seal or valve function.

C. Employees who wear respirators are permitted to leave the regulated area to wash their faces and respirator face pieces as necessary. This may be done to prevent skin irritation associated with respirator use or to change the filter elements if a change in breathing resistance or chemical vapor breakthrough is detected.

D. Every employee is required to perform a negative and positive seal check prior to respirator use.

VII MAINTENANCE OF RESPIRATORY PROTECTIVE EQUIPMENT:

All respirators shall be maintained using the procedures in 29 CFR 1910.134 Appendix B-2 or procedures recommended by the manufacturer, provided that such procedures are of equivalent effectiveness. The following methods shall be used to maintain the equipment:

A. Cleaning/Disinfecting
Respiratory equipment shall be washed thoroughly in warm water with detergent, using a soft brush. Detergents with a bactericide are preferable. If detergent with a bactericide is not used, the detergent wash shall be followed with a disinfecting rinse. Components shall be hand-dried with a clean lint free cloth or air dried before assembly.

APPENDIX E - RESPIRATORY PROTECTION PROGRAM

B. Storage
Dry, clean, disinfected respirators shall be sealed in clean plastic bags out of direct sunlight with the face piece and exhalation valve in a non-distorted position.

C. Repair
Repair and replacement of damaged parts must be done before the respirator can be used. Replacement parts must be those of the manufacturer of the equipment. Replacement parts are available at EH&S (Einstein) and Facilities Services (YU Campuses). Repairs or replacements must be performed by a qualified individual.

D. Inspection Procedures
All respirators shall be inspected by each user before and after each use and during cleaning. The following items will be examined during inspection:

1. Rubber Face piece

   a. Cracked or broken air-purifying element holder(s), badly worn threads or missing gasket(s).
   b. Excessive dirt.
   c. Cracks, tears, or holes.
   d. Distortion.
   e. Cracked, scratched, or loose-fitting lens (full face).
   f. Incorrectly mounted full face piece lens or broken/missing mounting clips.

2. Head Strap

   a. Breaks or tears.
   b. Loss of elasticity.
   c. Broken or malfunctioning buckles/attachments.
   d. Excessively worn serrations on head piece.
   e. Harness which might allow the face piece to slip.

3. Inhalation/Exhalation Valves

   a. Detergent residue, dust particles, dirt, or hair on valve or valve seat.
   b. Cracks, tears, distortion in valve material or valve seat.
   c. Improper insertion of the valve body in the face piece.
   d. Cracks, breaks, or chips in the valve body particularly in the sealing surface.
   e. Improper installation of the valve in the valve body.

4. Filter elements

   a. Incorrect cartridge, canister, or filter for the hazard.
   b. Missing or worn gaskets.
   c. Worn threads.
   d. Cracks or dents in filter housing.
   e. Incorrect installation, loose connections, or cross-threading in holder.
   f. Evidence of prior use of sorbent, cartridge, or canister, indicated by absence of sealing material, tape foil, etc. over inlet.

VIII TRAINING:

All employees in the program will be trained annually in the proper use and care of their respiratory equipment that have been assigned to them.

A. Training will include the following elements:

   1. Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator.

   2. What the limitations and capabilities are for the respirator.

   3. How to use the respirator effectively in routine and emergency situations, including situations in which the respirator malfunctions.

   4. How to inspect, doff and don, use, and check the seals of the respirator.

   5. What the procedures are for maintenance and storage of the respirator.

   6. How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators.

B. The training shall be conducted in a manner that is understandable to the employee.

C. The employer shall provide the training prior to requiring the employee to use a respirator in the workplace.

APPENDIX E - RESPIRATORY PROTECTION PROGRAM

IX PROGRAM EVALUATION:

A. Surveillance of the workplace will be conducted by EH&S on an ongoing basis to determine the necessity of respiratory protection.

B. This program will be reviewed and updated periodically via:

1. Review of training rosters.
2. Review of medical evaluation records.
3. Review of fit testing rosters.
4. Observation of compliance with care, use, and storage.
5. Enforcement of the program.
6. Review and observation of the appropriateness and competence of the fit testing program.

X RECORD KEEPING:

A. Records will be maintained at EH&S and will include the following:

1. Medical Evaluations.
2. Fit Testing.
3. A written copy of The YU/Einstein Respiratory Protection Program.
4. A copy of the OSHA Standard 29 CFR 1910.134.

B. All written materials are available at the YU and Einstein Environmental Health and Safety Office upon request.

XI CONTACT NUMBER:

EH&S at Einstein can be contacted at (718) 430-4152 or at YU at (212) 923-0784 for questions or clarifications regarding this Respiratory Protection Program.

APPENDIX F

STATEMENT OF MEDICAL SERVICES

APPENDIX F

STATEMENT OF MEDICAL SERVICES

At Einstein, employees who are potentially exposed to hazardous chemicals will be seen at either Employee Health Service at Jack D. Weiler Hospital, or Jacobi Hospital. Both hospitals have physicians who can determine if an individual has been over-exposed to a hazardous chemical.

AT YU, workers using respirators will be evaluated during the annual mobile medical exams. They should reveal any exposure they think they have had on the questionnaire and the physical evaluation. For sudden or accidental exposure, notify security and 911 and be evaluated by the hospital emergency room.

See **APPENDIX I** for emergency numbers.

APPENDIX G

LIST and LOCATIONS of REFERENCES and MATERIAL SAFETY DATA SHEETS

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LIST and LOCATIONS of REFERENCES and MATERIAL SAFETY DATA SHEETS

The following reference materials are available in the Department of Environmental Health and Safety Office, Forchheimer, Room 800.

Code of Federal Regulations: 49 Transportation, Revised, December 1, 1980.
:29 Labor, Revised July 1, 1993.
:OSHA 2206, Revised March 11, 1983.

Condensed Chemical Dictionary, Sixth Edition, Edited by Rose, Arthus and Elizabeth, Reinhold Publishing Corporation, New York, 1964.

The Condensed Chemical Dictionary, 9th Edition, Van Nostrand Reinhold Company.

CRC Handbook of Laboratory Safety, 2nd Edition, Norman V. Steere, CRC Press, Inc.

Degradation of Chemical Carcinogens, Milton W. Slein and Eric B. Sansone, Van Nostrand Reinhold Company, 1980.

Federal Register: Hazardous Waste and Consolidated Permit Regulations, May 1980.

Guide for Safety in the Chemical Laboratory, 2nd Edition, The Manufacturing Chemists Association.

Handbook of Occupational Safety and Health, Slote L., A Wiley-Interscience Publication, John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore, 1987.

Hazardous Chemical Safety, J.T. Baker, Inc., Phillipsburg, New Jersey, January 1, 1989 (First Printing).

Hazardous Chemical Spill Response, J.T. Baker, Inc., Phillipsburg, New Jersey, 1990.

Hazardous Materials 1980 Emergency Response Guidebook , U.S. Department of Transportation.

The Health Servo Amplifier Card, Model EU-900-CB, Health Company, Benton Harbor, Michigan, 1971.

The Industrial Environment, Its Evaluation & Control, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1973.

APPENDIX G (cont'd)

Industrial Ventilation, A Manual of Recommended Practice, 19th Edition, Committee on Industrial Ventilation, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1986.

J.T. Baker SAF-T-TRAINING Manual, Hazard Communication and Right-to-Know Training Program, Phillipsburg, New Jersey, Revised 1988.

Living in a Chemical World, Occupational and Environmental Significance of Industrial Carcinogens, Annals of the New York Academy of Sciences, Volume 543, The New York Academy of Science, New York, NY, 1988.

National Fire Codes, Volumes 1-12, National Fire Protection Association, Subscription Service, Battery Park, Quincy, Massachusetts.

NFPA - Fire Protection Guide on Hazardous Materials, 7th Edition (contains 325A, 325M, 49, 491M, 704M). Van Nostrand Reinhold Company.

NIOSH Intelligence Bulletins.

NIOSH Manual of Analytical Methods, 3rd Edition, Volume I, U.S. Department of Health & Human Services, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Physical Sciences and Engineering, Cincinnati, Ohio, February 1984.

NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, Volume 1 A-H, & Volume 2 I-Z, U.S. Department of Health and Human Services, Center for Disease Control, National Institute for Occupational Safety and Health, U.S. Department of Labor, Occupational Safety and Health Administration, Cincinnati, Ohio, January 1981.

NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, Cincinnati, Ohio, June 1990.

NYC Building Code, Fire Protection Handbook, 16th Edition National Fire Protection Association, 1986.

Occupational Health Guidelines for Chemical Hazards, Two Volumes, NIOSH/OSHA,1981.

Patty's Industrial Hygiene and Toxicology, 3rd Revised Edition, Volume I, General Principles, John Wiley & Sons, New York, Chichester, Brisbane, Toronto, 1978.

APPENDIX G - (cont'd)

Proceeding of the 1981 NIH Research Safety Symposium on Management of Hazardous Chemical Wastes in Research Institutions, Research Safety Monograph Series, Volume 5, Litton Bionetics, Inc. Safety Information Group, Maryland, 1981.

Proceedings of the 1982 NIH Research Safety Symposium on Chemical Emergencies in Laboratories - Planning and Response, Research Safety Monograph Series, Volume 6, Litton Bionetics, Inc., Safety Information Group, Maryland, 1982.

Proceeding of the National Cancer Institute Symposium on Laboratory Ventilation for Hazard Control, Cancer Research Safety Monograph Series, Volume 3, Litton Bionetics, Inc., Safety Information Group, Maryland, 1976.

Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, National Academy Press.

The Safe Handling of Chemical Carcinogen in the Research Laboratory, National Institute of Health, 1980.

Safe Handling of Chemical Carcinogens, Mutagnes, Teratogens, and Highly Toxic Substances, 2 Volumes, Douglas B. Walters, Ann Arbor Science Publishers, 1980.

Safety in Working with Chemicals, Green, M.E., Turk, A., Department of Chemistry, The City College of the City University of New York, MacMillan Publishing Company, New York, Collier MacMillan Publishers, London.

A complete set of hard copies of all Material Safety Data Sheets for chemicals in use at **Einstein** are located in the Forchheimer Building, Room 800. MSDSs are also stored on computer software and can be requested by calling (718) 430-4152. Additional copies can be found on the Ground Floor and 4th floor of Forchheimer, the 3rd floor of Kennedy the 1st, 3rd, 4th and 5th floors of the Price Building and in the school library and on the Internet at the following addresses: http://www.Einsteinyu.edu/ehs/msds_Link.htm or http://www.hazard.com.

For chemicals used in **Yeshiva University's** Manhattan Campuses, MSDSs can be found as follows:

	Wilf Campus: Belfer Hall - 1st floor (Ground Floor)
	Furst Hall - Basement (Housekeeping)
	Muss Hall - Basement (Maintenance Shop)
Midtown Campus:	245 Lexingrton Avenue - 5th Floor and Basement (Maintenance Shop)
	Brookdale Residence Hall - Basement (Paint Shop)
Cardozo School of Law:	Basement

Material Safety Data Sheets are also stored on computer software and can be requested by calling (718) 430-4152. Additional copies can be found on the Internet at the following addresses: http://www.hazard.com and http://www.Einsteinyu.edu/ehs/msds_Link.htm

APPENDIX H

"KNOWN HAZARDS OF, AND SPECIFIC PRECAUTIONS FOR, A SELECTED GROUP OF LABORATORY CHEMICALS".

APPENDIX H

"KNOWN HAZARDS OF, AND SPECIFIC PRECAUTIONS FOR, A SELECTED GROUP OF LABORATORY CHEMICALS".

The thirty-three (33) substances described below are offered for information purposes only. They, in no way, represent all hazardous chemicals in use at Albert Einstein College of Medicine or Yeshiva University.

Material Safety Data Sheets (MSDS) as well as other information regarding all chemicals in use at Albert Einstein College of Medicine are available from the Department of Environmental Health and Safety, Forchheimer Building, Room 800, (718) 430-4152. Copies of Material Safety Data Sheets can also be accessed on the Internet at the following address:
http://www.Einstein.yu.edu/ehs/msds_Link.htm. or http://www.hazard.com.

I.E

Known Hazards of and Specific Precautions for a Selected Group of Laboratory Chemicals

I.E.1 GENERAL CONSIDERATIONS

The following pages present a compilation of the chemical, physical, and physiological properties of 33 substances.

The number chosen for inclusion is arbitrary; the list is intended to be exemplary rather than exhaustive, for several reasons. For many of the hundreds of thousands of known chemicals, few, if any, toxicological data are available. Space limitations preclude inclusion of detailed information for more than a small fraction of the chemicals for which data are available. Moreover, the rapid progress of chemical and toxicological research ensure that new substances will be created every day and that new information on toxicology will have become available since these pages were assembled.

Each substance on the list satisfies some or all of the following criteria:

1. it is in common laboratory use;
2. under some conditions, it can constitute a known hazard; and
3. its properties and hazards may be encountered among a variety of chemicals and sometimes in many members of its class of chemicals.

In many cases, the description includes a cross-reference to another section of this report for instructions on proper handling of the substance.

It should be evident that the absence of a substance from this list *must not be interpreted as an indication that it is harmless.* On the contrary, the

laboratory worker is well advised to treat any chemical with respect and to adhere to good safety practice as outlined elsewhere in these guidelines.

Combined Effects of Chemicals

The user of these sheets should keep in mind that they contain information on pure substances and that, because of the innumerable possible combinations of chemicals, it is not feasible to describe all of the conceivable circumstances in which a new hazard can be created. Additional hazard may exist because of the formation of new products or by-products, because of impurities, or because of synergistic effects. The product of the reaction of ammonia and iodine, two common normally nonexplosive chemicals, is the highly shock-sensitive explosive, nitrogen triiodide. Syntheses of halogenated phenols may give rise to polyhalogenated dibenzofurans or polyhalogenated dibenzo-*p*-dioxins as unavoidable, although limited, by-products. Benzene is sometimes present in toluene, and β-naphthylamine is present as an impurity in α-naphthylamine; often, an impurity may be present in such small concentrations that, despite its toxic properties, it presents no significant hazard and this is usually true of these examples. But it should be kept in mind that impurities do present a potential hazard and that the actual hazard posed by an impurity, dependent on its concentration, must be judged in each specific case. The effect of ethanol enhances the hepatotoxic effect of carbon tetrachloride (see Safety Data Sheet).

Because the nature of the materials present in a given reaction mixture may not be known, especially in the research laboratory where new preparations are constantly being developed, it is wise to maintain at least the same level of safe practice in the disposal of chemical wastes and residues as in the actual preparative procedure. This is especially important in the case of the nonvolatile residues from distillations, in which impurities may be present in concentrated form.

Odor as an Indicator

The threshold detection limits for odors of chemicals given in these lists are necessarily approximate because of the wide variation in the sensitivity of individuals to specific odors; an obvious corollary is that the absence of odor is not a reliable guide to safe concentration levels in the laboratory environment. The hazard of a particular substance depends on its physical properties and toxicity and how it is being used. The most hazardous type of substance is one that is volatile and highly toxic but has only a faint odor or causes olfactory fatigue. For example, hydrogen cyanide has poor

warning properties and hydrogen sulfide rapidly produces olfactory fatigue.

HAZARDOUS PROPERTIES OF CLASSES OF CHEMICALS

Individual chemicals of a class, e.g., aliphatic amides, alcohols, and such, vary so widely in their hazardous properties that it is not possible to generalize for the class. The difference in toxicity between ethanol and methanol by the oral route exemplifies this point. Nevertheless, it is certainly true that many members of a class of compounds may have common or related physical and toxicological properties.

Therefore, prudence suggests that, until contrary information becomes available, it is advisable to assume that a hazard of a known substance may also be characteristic of its new close relative. For example, mercury, bismuth, osmium, lead, and other heavy metals frequently form toxic derivatives. Many diazo compounds and azides are explosives, and several polycyclic aromatic substances are carcinogens. Organophosphorus compounds may be neurotoxins.

I.E.2 SAFETY DATA SHEETS

The terms used in the Safety Data Sheets are defined below.

CARCINOGENIC Causing malignant (cancerous) tumors (OSHA, NIOSH, and FDA consider any tumor to be either a cancer or a precursor of a cancer)

ONCOGENIC Causing tumors

TUMORIGENIC Causing tumors

MUTAGENIC Causing a heritable change in the gene structure

EMBRYOTOXIC Poisonous to an embryo (without necessarily poisoning the mother)

TERATOGENIC Producing a malformation of the embryo

HUMAN CARCINOGEN A substance that has been shown by valid, statistically significant epidemiological evidence to be carcinogenic to humans

EXPERIMENTAL CARCINOGEN A substance that has been shown by valid, statistically significant experimental evidence to induce cancer in animals

ACGIH American Conference of Governmental Industrial Hygienists

NIOSH National Institute for Occupational Safety and Health

LC_{50} The concentration in air that causes death of 50% of the test animals: The test animal and the test conditions should be specified; the value is expressed in mg/liter, mg/m³, or ppm

LD_{50} The quantity of material that when ingested, injected, or applied to the skin as a single dose will cause death of 50% of the test animals: The test conditions should be specified; the value is expressed in g/kg or mg/kg of body weight

ALC The approximate lethal concentration in air for experimental animals: The test animal and the test condition should be specified; the value is expressed in mg/liter, mg/m³, or ppm

TLV®-TWA The threshold limit value established by the ACGIH: The time-weighted average concentration for a normal 8-hour workday or 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect

PEL Permissible exposure limits for the workplace, set by regulation and enforced by OSHA; most of these limit values were originally set, by consensus, by the ACGIH to assist industrial hygienists in implementing exposure control programs. As law, these are listed in 29 CFR 1910.1000 and subject to revision through the regulatory process.

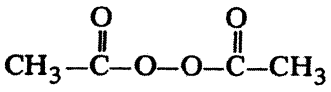
CFR Code of Federal Regulations

ACETYL PEROXIDE

CAS Registry No.: 110-22-5

Synonyms: Peroxide, diacetyl

Structure



Physical Properties

Molecular Weight: 118.1
Physical Form: Solid or colorless crystals or liquid
Melting Point: 30°C
Boiling Point: 63°C (21 mm Hg)
Explosion Hazard: Severe hazard when shocked or exposed to heat
Solubility: Slightly soluble in water; soluble in alcohol and hot ether

Toxicity and Hazard

Acetyl peroxide is irritating to the eyes, skin, and mucous membranes via the oral and inhalation routes. Application of two drops of a 30% solution (in dimethyl phthalate) has caused very severe corneal damage to rabbits.

Acetyl peroxide is a powerful oxidizing agent and can cause ignition of organic materials on contact. There are reports of detonation of the pure material; the 25% solution also has explosive potential, and inadvertent partial evaporation of even weak solutions can create explosive solutions or shock-sensitive crystalline material.

Special Handling Provisions

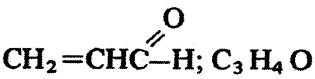
Acetyl peroxide is nearly always stored and handled as a 25% solution in an inert solvent. A face shield and rubber gloves should be worn when handling the substance, and a safety shield or hood door should be in front of apparatus containing it.

ACROLEIN

CAS Registry No.: 107-02-8

Synonyms: 2-Propenal, acrylaldehyde

Structure



$CH_2=CHC(=O)-H$; C_3H_4O

Physical Properties

Molecular Weight: 56.06
Physical Form: Colorless to yellowish liquid
Melting Point: −87°C
Boiling Point: 52.7°C
Flash Point: Less than −18°C
Specific Gravity (liquid): 0.8427 (20°C/20°C)
Vapor Density (air = 1): 1.94
Vapor Pressure: 214 mm Hg (20°C)
Solubility: 20.8% by weight in water (with which it forms an azeotrope boiling at 52.4°C containing 97.4% acrolein)
Odor: Pungent and intensely irritating; threshold = 0.3-0.4 ppm

Toxicity and Hazard

After 1 min exposure to 1 ppm acrolein, volunteers have experienced slight nasal irritation; moderate nasal irritation and almost intolerable eye irritation with lacrimation developed in 5 min. At an acrolein level of 5 ppm, the latter effects were seen in 1 min. Inhalation of air containing 10 ppm acrolein may be fatal in a few minutes. Inhalation sufficient to cause intense lacrymation and nasal irritation may lead to slowly developing pulmonary edema in the course of 24 hours. Liquid acrolein in the eye or on the skin can produce serious injury.

Acrolein is highly toxic to animals via the inhalation and the oral routes: ALC (rats, 4-hour inhalation) = 9 ppm; LD_{50} (rats, oral) = 46 mg/kg. It is moderately toxic via skin absorption: LD_{50} (rabbits) = 200 mg/kg. Liquid acrolein is corrosive to skin, and skin sensitization can also occur. A 1% solution of acrolein caused severe eye injury to rabbits, and acrolein vapors can also cause damage to the eyes.

Ninety-day continuous exposure to acrolein at 0.21 and 0.23 ppm had no adverse effects on rats, guinea pigs, monkeys, or dogs. There was also no effect when the same species were exposed to 0.7 ppm for 6 weeks; however, similar exposures at 3.7 ppm produced toxic effects in the monkeys and dogs.

Special Handling Provisions

The TLV and the OSHA PEL for acrolein are 0.1 ppm (0.25 mg/m^3) as an 8-hour time-weighted average. The exposure limit over any 15-min period is 0.3 ppm.

Although the irritating odor of acrolein provides a useful warning, its high toxicity makes it advisable to carry out laboratory operations using it in a hood. Because of its high volatility and flammability, acrolein should not be handled near open flames.

ACRYLONITRILE

CAS Registry No.: 107-13-1

Synonyms: AN, cyanoethylene, 2-propenenitrile, VCN, vinyl cyanide

Structure

$CH_2=CHC\equiv N$; C_3H_3N

Physical Properties

Molecular Weight: 53.06
Physical Form: Colorless, mobile liquid
Melting Point: −82°C
Boiling Point: 77°C
Flash Point: −1°C
Autoignition Temperature: 481°C
Explosive Limits: 3.1-17% by volume in air
Specific Gravity: 0.806 (20°C/4°C)
Vapor Density (air = 1): 1.83
Vapor Pressure: 80 mm Hg (20°C)

Toxicity and Hazard

Depending on the amount and rapidity of absorption into the body, acrylonitrile can produce nausea, vomiting, headache, sneezing, weakness, light-headedness, asphyxia, and even death by inhalation, skin contact, or inadvertent ingestion. These toxic effects may be partially due to conversion of acrylonitrile to cyanide in the body.

The liquid can irritate eye and skin, and blistering has resulted after prolonged, apparently harmless, contact with previously contaminated clothing. The previously established workroom air concentration limit of 20 ppm appears adequate to prevent most adverse health effects of acrylonitrile. OSHA reduced the workplace exposure limit to 2 ppm with a ceiling value of 10 ppm for a single daily 15-min excursion following reports of cancer induction in animals and concern regarding its possible carcinogenicity to humans. Exposures at or lower than these levels should afford protection against that health risk.

Acrylonitrile is a flammable liquid. Fire hazard exists when this compound is exposed to heat, flame, or oxidizing agents. The substance also presents a moderate explosion hazard when exposed to flame. Acrylonitrile can react violently with strong acids, amines, strong alkalis, or bromine.

Special Handling Provisions

Acrylonitrile is regulated as a human carcinogen by OSHA (29 CFR 1910.1045). The PEL is 2 ppm as an 8-hour time-weighted average or 10 ppm as averaged over any 15-min period. Dermal or eye contact with liquid acrylonitrile is also prohibited. Where feasible, worker exposure must be controlled by engineering methods or work practices. Laboratory hoods that have been demonstrated to provide sufficient protection should

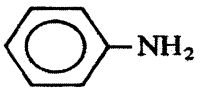
be used, and closed systems are recommended for laboratory operations. Use of gloves (see Table 3) and goggles when handling liquid acrylonitrile is also recommended. OSHA regulations also require that exposure monitoring be conducted for all acrylonitrile operations to determine the airborne exposure levels for workers. In situations where the 15-min or 8-hour exposure limits are exceeded and engineering or administrative controls are not feasible, respiratory protection must be employed based on the expected exposure level. In cases of unknown concentration or fire fighting, supplied-air or self-contained breathing apparatus with a full facepiece operated in the positive-pressure mode is required. There are other detailed requirements in the OSHA standard related to housekeeping, waste disposal, hygiene facilities, employee training, and medical monitoring. Managers and laboratory supervisors should review these requirements before starting work with acrylonitrile.

ANILINE

CAS Registry No.: 62-53-3

Synonyms: Aminobenzene, benzenamine, phenylamine

Structure



$C_6H_5NH_2$

Physical Properties

Molecular Weight: 93.12
Physical Form: Colorless, oily liquid
Melting Point: −6.3°C
Boiling Point: 184°C
Flash Point: 158°C (closed cup)
Specific Gravity (liquid): 1.0217 (20°C)
Vapor Density (air = 1): 3.22
Vapor Pressure: 0.67 mm Hg (25°C)
1.0 mm Hg (30.6°C)
10.0 mm Hg (68.3°C)
Solubility: 3.5 g/100 ml water (20°C); miscible in most organic solvents
Odor: Characteristic odor and burning taste; threshold = 0.5 ppm

Toxicity and Hazard

An oral lethal dose of aniline for humans is 15-30 ml. Skin contact is the most common route of entry; the outstanding feature of aniline poisoning in humans is cyanosis due to formation of methemoglobin. The symptoms of severe exposure are cyanosis, headache, weakness, dizziness, nausea, and chills. Onset of symptoms, however, may be delayed up to 4 hours.

Aniline is moderately toxic via the skin and inhalation routes: LD_{50} (rabbits; skin) = 1540 mg/kg, ALC (rats, 4-hour inhalation) = 550 ppm. It is slightly toxic to animals via the oral route: LD_{50} (rats) = 633 mg/kg. Aniline is a moderate eye irritant and can cause mild skin irritation.

Rats fed 10, 30, or 100 (mg/kg of body weight)/day of aniline hydrochloride for 1 year experienced decreased red blood cell counts and hemoglobin concentrations and alterations of the spleen. Dogs, rats, mice, and guinea pigs exposed to 5 ppm aniline in the air daily for 6 months showed only slight methemoglobin. Exposure to 20 or 35 ppm caused 18-43% mortality; changes were seen in the liver, kidney, and spleen, and there was a marked effect on the composition of the blood.

Lifetime feeding studies in animals thus far do not answer the question of carcinogenicity but, if aniline is a carcinogen, it is not a potent one in animals. Animal studies now in progress should answer the question. Epidemiological studies of aniline workers have not found a relationship between aniline exposure and bladder tumors.

Special Handling Provisions

The TLV for aniline is 2 ppm (10 mg/m^3) as an 8-hour time-weighted average. The OSHA PEL is 5 ppm. These limits include a warning about the potential contribution of skin absorption to the overall exposure.

Because aniline, like many aromatic amines, is a rather toxic substance that readily penetrates the skin, it should be handled carefully. Most laboratory operations should be carried out in a hood, and skin contact should be avoided by appropriate use of protective apparel, e.g., rubber gloves and aprons.

BENZENE

CAS Registry No.: 71-43-2

Synonyms: Benzol, phenyl hydride, coal naphtha, mineral naphtha

Hazards and Precautions for a Selected Group of Chemicals *111*

Structure

C_6H_6

Physical Properties

Molecular Weight: 78.1
Physical Form: Colorless liquid
Melting Point: 6°C
Boiling Point: 80°C
Flash Point: −11°C
Explosive Limits: 1.3-7.1% by volume in air
Specific Gravity: 0.8787 (20°C/4°C)
Vapor Density (air = 1): 2.8
Vapor Pressure: 95 mm Hg (20°C)
Solubility: Miscible with most organic solvents

Toxicity and Hazard

In humans, acute inhalation exposure to benzene can produce a picture of acute delirium, characterized by excitement, euphoria, and restlessness and, if the exposure is significantly high, the symptoms may progress to depression, drowsiness, stupor, and even unconsciousness. The concentration required to produce this symptom complex is 1000 ppm or higher. These concentrations will also produce irritation of the eyes, nose, and respiratory tract.

Chronic inhalation exposure to 25-50 ppm of benzene can produce changes in the blood picture that include macrocytosis, decrease in the total red blood count, decrease in platelets, decrease in the hemoglobin concentration, or decrease in leukocytes. Any or all of these hematologic effects may be seen in any individual. Usually, the worker will be asymptomatic while these effects are observed in the blood picture. Continued exposure at somewhat higher concentrations (probably more than 100 ppm) can insidiously result in a more severe blood picture that includes leukopenia or even aplastic anemia, with symptoms of headaches, dizziness, loss of appetite, nervousness, irritability, and perhaps bleeding manifestations, i.e., nosebleeds, easy bruisability, or hematuria. Severe cases may have fatal outcomes.

Recently, a number of reports have been published that describe leukemia in workers who have had aplastic anemia. These cases have been reported in Italy and Turkey in workers exposed to grossly high concentrations of benzene. In addition, there is some indication that an

excess of leukemia may occur without a preceding picture of aplastic anemia in workers who have been repeatedly exposed to benzene at concentrations of more than 100 ppm.

Special Handling Provisions

The current OSHA PEL for benzene [29 CFR 1910.1000(b) (Table Z-2)] is 10 ppm as an 8-hour time-weighted average, 25 ppm for a ceiling concentration for time periods such that the 8-hour TWA is not exceeded, and a peak above the ceiling of 50 ppm for no more than 10 min.

Benzene is a flammable liquid and should not be exposed to heat or flame. An explosion hazard also exists when its vapors are exposed to flame. Benzene may react vigorously with oxidizing agents such as bromine pentafluoride, chlorine, chromic acid, nitryl perchlorate, oxygen, ozone, perchlorates, aluminum chloride plus fluorine perchlorate, sulfuric acid plus permanganates, potassium peroxide, silver perchlorate plus acetic acid, and sodium peroxide.

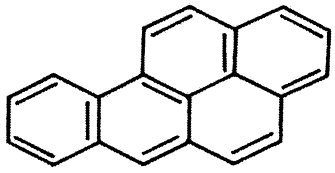
Benzene operations in laboratories should be carried out in closed systems or in laboratory hoods that have been shown to have adequate protection factors to prevent significant worker exposure. When contact with liquid benzene is possible, skin-protection measures (see Table 3) should be employed. Before starting work with benzene, the worker should consult the OSHA standard, which requires more stringent precautions than does Procedure A (see Section I.B.8).

BENZO[*a*]PYRENE

CAS Registry No.: 50-32-8

Synonyms: 3,4-Benzpyrene

Structure



$C_{20}H_{12}$

Physical Properties

Molecular Weight: 252.3

Physical Form: Yellowish plates
Melting Point: 179°C
Boiling Point: 311°C
Solubility: Soluble in toluene, benzene, and xylene; sparingly soluble in methanol and ethanol

Toxicity and Hazard

There is very little information available on the acute (single-dose) toxicity of benzo[*a*]pyrene. Its acute oral toxicity is very low, probably because it is poorly absorbed by the gastrointestinal tract. Single contact with a 1% solution in toluene does not cause skin irritation, but repeated contact can cause systemic effects.

The TLV committee of ACGIH has rated benzo[*a*]pyrene as an occupational substance "suspect of oncogenic potential for workers." Although there are insufficient data to prove its carcinogenicity in humans, benzo[*a*]pyrene is a well-established animal carcinogen, affecting a variety of tissues including lungs, skin, and stomach. It is known to occur in coal-tar and other carcinogenic mixtures and has been identified as an active constituent of carcinogenic pitch.

Special Handling and Provisions

No TLV for benzo[*a*]pyrene has been set. Its carcinogenic potency in animals is high enough to justify the use of Procedure A (see Section I.B.8) when handling more than a few milligrams in the laboratory.

BIS(CHLOROMETHYL)ETHER

CAS Registry No.: 542-88-1

Synonyms: Methane, oxybis(chloro)-; BCME; chloromethyl ether; dichloromethyl ether; ether, bis(chloromethyl)

Structure

$ClCH_2OCH_2Cl$; $C_2H_4Cl_2O$

Physical Properties

Molecular Weight: 115.00
Physical Form: Colorless liquid
Melting Point: −41.5°C

Boiling Point: 104°C
Specific Gravity (liquid): 1.315 (20°C/4°C)
Vapor Density (air = 1): 4.0
Solubility: Miscible in all proportions with ethanol, ether, and many organic solvents; decomposes in water to give HCl and formaldehyde.
Odor: Suffocating

Toxicity and Hazard

Because of the high volatility of bis(chloromethyl)ether (BCME), inhalation is the route of exposure that presents the greatest hazard to humans. BCME vapor is severely irritating to the skin and mucous membranes and can cause corneal damage that heals slowly. The substance has caused lung cancer in humans.

BCME is highly toxic to animals via inhalation: LD_{50} (rats, 7-hour inhalation) = 7 ppm. It is moderately toxic via the oral and skin routes: LD_{50} (rats, oral) = 280 mg/kg; LD_{50} (rabbits, skin) = 368 mg/kg. Its vapors are strongly irritant to the eyes of rats.

Rats and hamsters subjected to 10 or 30, 6-hour exposures of 1 ppm BCME showed evidence of tracheal and bronchial hyperplasia, as well as effects on the central nervous system.

BCME is carcinogenic to mice following inhalation, skin application, or subcutaneous administration. In newborn mice, it is carcinogenic after a single subcutaneous exposure. In the rat, it is carcinogenic by inhalation and subcutaneous administration. BCME is a lung carcinogen in humans.

Special Handling Provisions

The TLV for BCME is 0.001 ppm (1 ppb; 5 $\mu g/m^3$). The substance is classified by ACGIH as a human carcinogen. OSHA has classified BCME as a cancer-suspect agent and has stringent regulations (29 CFR 1910.1008) for its use if its concentration in a material exceeds 0.1%. The regulations, which call for more precautions than does Procedure A (see Section I.B.8), should be consulted before starting work with BCME.

BROMINE

CAS Registry No.: 7726-95-6

Structure

Br_2

Physical Properties

Molecular Weight: 159.83
Physical Form: Dark reddish-brown liquid
Melting Point: −7.27°C
Boiling Point: 58.8°C
Flash Point: None
Specific Gravity (liquid): 3.11 (20°C/4°C)
Vapor Density (air = 1): 3.5
Vapor Pressure: 175 mm Hg (20°C)
Solubility: Soluble in alcohol, ether, chloroform, and carbon disulfide
Odor: Irritating and penetrating; threshold = 1.5-3.5 ppm.

Toxicity and Hazard

Fourteen mg/kg of Br_2 is a lethal oral dose for humans. Inhalation of Br_2 has caused coughing, nosebleeds, dizziness, and headache, followed after some hours by abdominal pain, diarrhea, and skin rashes. Severe irritation of the respiratory passages and pulmonary edema can also occur. Lacrimation occurs at levels of less than 1 ppm. It is reported that 40-60 ppm are dangerous for short exposures, and 1000 ppm can be fatal. The substance produces irritation and destruction of the skin with blister formation. Severely painful and destructive eye burns may result from contact with either liquid or concentrated vapors of Br_2.

Bromine is moderately toxic to animals via the inhalation route and slightly toxic via the oral route: LC_{50} (mice, 1.7-hour inhalation) = 240 ppm; LD_{50} (rats, oral) = 3100 mg/kg. The respiratory irritation threshold for Br_2 in rats is 1.4 ppm.

Rats fed 0.01 mg/kg Br_2 for 6 months experienced changes in their conditioned reflexes and several blood indexes. Rats, mice, and rabbits inhaling 0.2 ppm of Br_2 for 4 months developed disturbances in the functions of their respiratory, nervous, and endocrine systems; 0.02 ppm did not cause any adverse effects.

Special Handling Provisions

The TLV and the OSHA PEL for Br_2 are 0.1 ppm (0.7 mg/m^3) as an 8-hour time-weighted average. The exposure limit suggested by ACGIH is 0.3 ppm over any 15-min period.

Splash goggles and rubber gloves (see Table 3) should be worn when handling more than a few milliliters of pure liquid Br_2. Although the irritating odor of Br_2 provides a warning, it is best to carry out laboratory

operations with it in a hood. Accidental contact with the skin must be immediately counteracted by washing with water. A worker whose clothing has been doused with liquid Br_2 is in severe danger unless the affected clothing is removed immediately.

CARBON DISULFIDE

CAS Registry No.: 75-15-0

Synonyms: Carbon bisulfide, dithiocarbonic anhydride, sulphocarbonic anhydride

Structure

S=C=S ; CS_2

Physical Properties

Molecular Weight: 76.14
Physical Form: Colorless liquid
Melting Point: —108.6°C
Boiling Point: 46.3°C
Flash Point: —30°C (closed cup)
Flammable Limits: 1.25-50.0% by volume in air
Autoignition Temperature: 100°C
Specific Gravity: 1.2626 (20°C)
Vapor Density (air = 1): 2.63
Vapor Pressure: 360 mm Hg (25°C)
Refractive Index: 1.6232 (25°C)
Conversions: 1 ppm = 3.11 mg/m^3
1 mg/m^3 = 0.32 ppm
Solubility: 0.22 g/100 ml water (22°C); miscible with alcohol, ether, and benzene
Odor: Almost odorless when pure; commercial samples may have a disagreeable odor due to trace of other sulfur compounds

Toxicity and Hazard

Carbon disulfide is rapidly absorbed when inhaled, and inhalation can produce acute poisoning. Poisoning can also occur from ingestion; death has been known to occur after ingestion of as little as 15 ml.

Acute poisoning by ingestion or inhalation can produce narcosis,

accompanied by delirium. This may progress to areflexia, paralysis, coma, and death. Mental disorders or polyneuritis have been reported as sequelae. It is reported that exposure in excess of 500 ppm is required before acute effects will be noted.

Poisoning resulting from chronic exposure was reported frequently in the older literature but rarely in the last 10 to 20 years. Chronic exposure has resulted in neuropsychiatric manifestations with mental disorders, including psychoses, weakness, paralysis, parkinsonism, and blindness or in polyneuritis with pain along nerves, loss of strength, and paresthesias.

In milder exposures, the reported effects have been attributed to cerebral vascular damage with symptoms related to central nervous system damage involving pyramidal, extrapyramidal, and pseudobulbar tracts. There are also reports of hypertension, renal damage, elevated cholesterol, and early arteriosclerosis. Some recovery from these effects is the rule, but such recovery is slow, occurring over months or years, and some paralysis may persist. There have also been reported effects on the reproductive system in both sexes, with women having menstrual disorders, abortions, and infertility, and males having spermatic disorders.

Carbon disulfide is a very flammable substance; a steam pipe or even a hot radiator can ignite its vapors. It also has a very wide range of explosive concentrations and thus should not be exposed to heat, flame, sparks, or friction. Carbon disulfide reacts violently with aluminum, chlorine, azides, cesium azide, chlorine monoxide, ethylene diamine, ethyleneimine, fluorine, lithium azide, nitric oxide, nitrogen tetroxide, sulfuric acid plus permanganates, potassium, potassium azide, rubidium azide, zinc, and various other oxidizing agents. When CS_2 is used to desorb organic materials from activated charcoal, as in the case of air sample analysis, a significant amount of heat can be liberated.

Special Handling Provisions

OSHA regulations require that worker 8-hour time-weighted average exposures not exceed 20 ppm; ceiling levels of 30 ppm are acceptable to the point that the 8-hour TWA is not exceeded, and additional peak exposures up to 100 ppm for no more than 30 min are allowable. ACGIH has decreased (1980) the 8-hour time-weighted average exposure to 10 ppm and has noted that skin absorption can significantly contribute to toxic effect.

Gloves (see Table 3) and protective apparel should be used when handling liquid CS_2. As much as possible, laboratory operations should be confined to a hood that has protection factors high enough to prevent significant exposure or to closed systems.

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CARBON TETRACHLORIDE

CAS Registry No.: 56-23-5

Synonyms: Halon 104, perchloromethane, tetrachloromethane

Structure

CCl_4

Physical Properties

Molecular Weight: 153.8
Physical Form: Liquid
Melting Point: −23°C
Boiling Point: 76.5°C
Specific Gravity: 1.5940 (20°C/4°C)
Vapor Density (air = 1): 5.3
Vapor Pressure: 115 mm Hg (25°C)
Solubility: 0.080% in water (25°C); miscible with most organic solvents

Toxicity and Hazard

Although inhalation of CCl_4 can cause depression of the central nervous system with dizziness, headaches, depression, mental confusion, and even unconsciousness, such effects probably are the result of exposure at concentrations of 100-500 ppm, and serious poisonings rarely occur. Ingestion of as little as 4 ml of CCl_4 has been reported to be fatal. Many deaths have occurred from accidental ingestion; the early initial symptom is central nervous system depression, which usually clears the second day. Then, if the dose has been large enough, the victim may become jaundiced and, if the dose is sufficiently large, he or she may die in a few days. If the dose is smaller, the liver effects partially abate, only to have the victim go into renal failure with anuria, oliguria, uremia, proteinuria, and possibly death. Acute inhalation has produced almost the identical picture. In addition, occasionally, very brief inhalations of CCl_4 have been reported to produce sudden death thought to be due to ventricular fibrillation.

Chronic inhalation of CCl_4 at concentrations of 10-100 ppm has resulted in liver damage, which can be detected by abnormal liver function tests, and liver biopsies have disclosed centrilobular necrosis. Chronic exposure in animals has resulted in the appearance of cirrhosis and of hepatomas. There is little information regarding effects of chronic exposure in humans other than the laboratory abnormalities as described. A few cases of

cirrhosis and hepatic cancer have been reported, but causal relationship to CCl_4 is difficult to confirm or deny. Prolonged exposure of the skin to the solvent can result in extreme dryness and fissuring, with redness and some secondary infection.

Ingestion of alcohol has been implicated repeatedly as predisposing the worker to increased effects of liver damage from CCl_4 exposure.

Although CCl_4 is nonflammable, on exposure to heat or flame it may decompose with the formation of phosgene. Severe reaction has been observed with allyl alcohol, aluminum, tetraethylaluminum, barium, benzoyl peroxide plus ethylene, beryllium, bromine trifluoride, calcium hypochlorite, diborane, ethylene, dimethyl formamide, disilane, fluorine, lithium, magnesium, liquid oxygen, plutonium, silver perchlorate plus hydrochloric acid, potassium tert-butoxide, sodium, potassium, tetrasilane, trisilane, uranium, zirconium, and burning wax.

Special Handling Provisions

The current OSHA PEL and TLV are 10 ppm as an 8-hour time-weighted average, 25 ppm as a ceiling for any period of time provided the 8-hour average is not exceeded, and 200 ppm for 5 min in a 4-hour period; in 1980, the ACGIH proposed a change to 5 ppm for an 8-hour time-weighted average and a ceiling exposure level of 20 ppm for up to 15 min on the basis that CCl_4 is suspected to have carcinogenic potential in humans. ACGIH also states that skin contact may account for a substantial part of toxic response.

Because the carcinogenic potency of CCl_4 is low, Procedure B (see Section I.B.7) provides adequate protection for laboratory operations in which it is used. All operations should be carried out in a hood, not only because of the carcinogenicity of the substance, but also because of its other toxic effects and its volatility. Nitrile rubber is the recommended material for gloves and other protective clothing.

CHLORINE

CAS Registry No.: 7782-50-5

Structure

Cl_2

Physical Properties

Molecular Weight: 70.91
Physical Form: Greenish-yellow gas
Melting Point: −101°C
Boiling Point: −34.1°C
Flash Point: Not flammable
Specific Gravity (liquid): 1.424 (15°C)
Vapor Density (air = 1): 2.4
Vapor Pressure: 400 mm Hg (25°C)
Solubility: 1.46% in water (25°C)
Odor: Penetrating and irritating; threshold = 0.3 ppm

Toxicity and Hazard

Humans can generally detect the odor of chlorine at about 0.3 ppm. Minimal irritation of the throat and nose are noticed at about 2.6 ppm and painful irritation at about 3.0 ppm; at a range of 2.6-41.0 ppm, a group of "trained industrial hygienists" noted "strong irritation." The subjective response to chlorine is less pronounced with prolonged exposure.

Experimentally determined responses to chlorine by humans are not very consistent. Throat irritation occurs at about 6.6-15 ppm. However, an exposure for medical purposes of a large number of humans to 5-7 ppm for 1 hour did not result in serious or long-term consequences. Exposure to about 17 ppm causes coughing, and levels as low as 10 ppm may cause lung edema.

Human exposure to 14-21 ppm for 30 min to 1 hour is regarded as dangerous and may, after a delay of 6 or more hours, result in death from anoxia due to serious pulmonary edema. For rats, the LC_{50} (1 hour) = 293.

Chronic effects on humans from long-term low-level exposures have not been well documented. Animal exposures have indicated that prolonged exposure to approximately 1.7 ppm for 1 hour per day may cause deterioration in the nutritional state, blood alteration, and decreased resistance to disease.

Special Handling Conditions

The TLV and the OSHA PEL are 1 ppm (3 mg/m^3) as a ceiling. NIOSH has recommended a ceiling limit of 0.5 ppm over any 15-min period. The ACGIH 15-min exposure limit is 3 ppm.

Chlorine should be kept away from easily oxidized materials. Chlorine

reacts readily with many organic chemicals, sometimes with explosive violence. Because of the high toxicity of chlorine, laboratory operations using it should be carried out in a hood (see Section I.B.7) and appropriate gloves (see Table 3) should be worn.

CHLOROFORM

CAS Registry No.: 67-66-3

Synonym: Trichloromethane

Structure

$CHCl_3$

Physical Properties

Molecular Weight: 119.39
Physical Form: Colorless liquid
Melting Point: −63.5°C
Boiling Point: 61.26°C
Flash Point: None
Specific Gravity: 1.49845 (15°C)
Vapor Pressure: 100 mm Hg (10.4°C)
Vapor Density (air = 1): 4.12
Solubility: 0.74% in water (25°C); miscible with most organic solvents

Toxicity and Hazard

Inhalation exposure to $CHCl_3$ at concentrations greater than 1000 ppm can produce dizziness, nausea, and headache. At higher concentrations, there can be disorientation and delirium progressing to unconsciousness. Such high exposures can also produce liver and possibly kidney damage. It is believed that $CHCl_3$ can sensitize the heart to adrenaline, so it may cause cardiac arrhythmias and possibly death.

High concentrations of the vapor can produce conjunctivitis. Liquid $CHCl_3$ in the eye will produce a painful corneal injury that usually heals in several days.

Chronic exposure to $CHCl_3$ at concentrations of 100-200 ppm has been reported to produce enlarged livers. Continued contact with the skin can produce drying, fissuring, and inflammation.

In experimental studies, prolonged ingestion of high levels of $CHCl_3$ by mice resulted in liver cancers and by rats, kidney tumors.

Although the fire hazard of $CHCl_3$ is slight, exposure to heat or flame can result in generation of phosgene gas. $CHCl_3$ reacts violently with acetone plus a base, aluminum, disilane, lithium, magnesium, nitrogen tetroxide, potassium, perchloric acid plus phosphorus pentoxide, potassium hydroxide plus methanol, potassium *tert*-butoxide, sodium, sodium hydroxide plus methanol, sodium methylate, or sodium hydride.

Special Handling Conditions

The current OSHA PEL for $CHCl_3$ is 50 ppm as an 8-hour time-weighted average. This standard is also a ceiling level that should not be exceeded for any 15-min period. The ACGIH currently recommends that $CHCl_3$ be treated as a suspect human carcinogen and recommends an 8-hour time-weighted average exposure of 10 ppm.

Although $CHCl_3$ has caused tumors in animals, its potency is low. Hence, Procedure B (see Section I.B.7) provides adequate protection during laboratory operations with it. The high volatility of $CHCl_3$ emphasizes the importance of a hood for such operations. Polyvinyl alcohol gloves provide the best hand protection.

DIETHYL ETHER

CAS Registry No.: 60-29-7

Synonyms: Ethane, 1,1'-oxybis-; ethyl ether; ether

Structure

$CH_3CH_2OCH_2CH_3$; $C_4H_{10}O$

Physical Properties

Molecular Weight: 74.12
Physical Form: Colorless liquid
Melting Point: −116.3°C (stable crystals)
Boiling Point: 34.6°
Flash Point: −45° (closed cup)
Explosive Limits: 1.9-36.5% by volume in air
Autoignition Temperature: 180°C
Specific Gravity (liquid): 0.7146 (20°C/20°C)

Vapor Density (air = 1): 2.55
Vapor Pressure: 438.9 mm Hg (20°C)
Solubility: 8.43 wt-% in water (15°C); 6.05 wt-% in water (25°C)
Odor: Sweetish, pungent (characteristic); threshold = 0.2 ppm

Toxicity and Hazard

Repeated exposure of humans to diethyl ether via inhalation has caused loss of appetite, exhaustion, headache, and other symptoms. General anesthesia occurs at a concentration of 3.6-6.5% in air. Human subjects found diethyl ether irritating to the nose but not to the eyes or throat at a level of 200 ppm. Acute overexposure produces vomiting, paleness, irregular respiration, and low pulse rates and body temperatures. The human oral lethal dose for diethyl ether is about 420 mg/kg.

Diethyl ether is slightly toxic to animals via the oral route: LD_{50} (rats) = 1700 mg/kg. It is a mild skin irritant. Its absorption through the skin is not usually great enough to cause a deleterious effect. Diethyl ether can cause eye irritation but not any permanent damage. It has very low toxicity via inhalation: LC_{50} (mice, 3-hour inhalation) = 42,500 ppm.

Diethyl ether is hazardous in several ways. Diethyl ether readily forms explosive peroxides on exposure to air, sometimes leading to explosive residues when it is distilled.

Special Handling Conditions

The TLV and the OSHA PEL for diethyl ether are 400 ppm (1200 mg/m^3) as an 8-hour time-weighted average. The exposure limit is 500 ppm over any 15-min period.

Because of its high volatility and flammability, diethyl ether should be used in a hood that has a spark-proof mechanical system and be kept well away from flames or sparking devices. It should be stored in a cool place, preferably an explosion-proof refrigerator. Opened bottles of diethyl ether, even those containing an oxidation inhibitor such as BHT, should not be kept more than a few months to avoid the hazard of peroxide formation. Uninhibited ether, such as that specifically prepared for anesthesia use, should be handled with particular care.

DIMETHYLFORMAMIDE

CAS Registry No.: 68-12-2

Synonym: DMF

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Structure

$HC(=O)-N(CH_3)_2$; C_3H_7NO

Physical Properties

Molecular Weight: 73.1
Physical Form: Colorless, mobile liquid
Melting Point: −61°C
Boiling Point: 152.8°C
Flash Point: 136°C
Autoignition Temperature: 445°C
Explosive Limits: 2.2-15.2% by volume in air at 100°C
Specific Gravity: 0.9445 (25°C/4°C)
Vapor Density (air = 1): 2.51
Vapor Pressure: 3.7 mm (25°C)

Toxicity

Human overexposure to DMF may produce gastrointestinal effects. Employees in a French textile plant using DMF developed digestive symptoms including burning, nausea, vomiting, and stomach cramps, probably from irritation of the digestive mucosa. The symptoms subsided with absence from work and reappeared when work was resumed.

In experimental studies, animal exposures indicate that dimethylformamide is only slightly toxic via the inhalation and the oral routes: LC_{50} (rats) = 5000 ppm and LD_{50} (rats, oral) = 3967 mg/kg. It is moderately toxic when placed on the skin: LD_{50} (rabbits, percutaneous) = 4720 mg/kg. When placed on the skin, it produced slight inflammation of the skin, and when placed in the eye, it produced corneal injury.

Animal experimentation also indicates that dimethylformamide is not a teratogen.

The fire hazard of dimethylformamide is only moderate when the substance is exposed to heat or flame. Materials for which contact should be avoided include inorganic nitrates, bromine, chromic acid, organic nitrates, phosphorus pentoxide, and tetraethylaluminum.

Special Handling Provisions

The current OSHA PEL for dimethylformamide is 10 ppm as an 8-hour time-weighted average. It is advised that significant toxicity can result

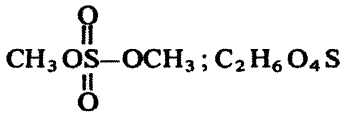
from skin contact. Therefore, gloves or other protective apparel (preferably of butyl rubber) should be worn when handling liquid DMF. It should also be noted that use of DMF as a solvent for toxic materials that are not ordinarily absorbed may increase their skin contact hazard.

DIMETHYL SULFATE

CAS Registry No.: 77-78-1

Synonyms: DMS; dimethyl monosulfate; sulfuric acid, dimethyl ester

Structure



$CH_3OS(=O)_2OCH_3$; $C_2H_6O_4S$

Physical Properties

Molecular Weight: 126.13
Physical Form: Colorless, waterlike liquid
Melting Point: −31.8°C
Boiling Point: 188.8°C
Flash Points: 116°C (open cup)
83°C (closed cup)
Specific Gravity (liquid): 1.328 (20°C)
Vapor Density (air = 1): 4.35
Vapor Pressure: 0.54 mm Hg (20°C)
Solubility: 2.8 g/100 ml of water (18°C); hydrolyzes to sulfuric acid and methanol in water; soluble in alcohol, ether, and benzene
Odor: Slight; not distinctive

Toxicity and Hazard

Many cases of DMS poisoning have been reported. The common initial symptoms are headache and giddiness, with burning of the eyes. The patient's condition may worsen, with painful eyes, nose and throat irritation, loss of voice, coughing, difficulty in breathing and swallowing, vomiting, and diarrhea possible. The onset of these symptoms may be delayed for up to 10 hours.

Skin contact causes blistering and necrosis, and DMS can be absorbed

through the skin in sufficient quantity to cause systemic intoxication. In the worst cases, there is severe inflammation of the mucous membranes and pulmonary injury that may be fatal; several deaths have occurred. For example, exposure to 97 ppm for 10 min was fatal.

DMS is moderately toxic to animals via the oral route: LD_{50} (rats) = 440 mg/kg. Undiluted DMS produced moderate to severe irritation when applied to the skin of guinea pigs; 1% DMS produced mild irritation. DMS does not cause skin sensitization in animals. Undiluted DMS applied to rabbit eyes produced severe injury. Even a 1-hour exposure to 58 ppm has resulted in permanent eye damage in rats. During a 4-hour exposure, 30 ppm DMS killed five out of six rats, but 15 ppm was not lethal.

DMS has been shown to be carcinogenic in the rat by inhalation, subcutaneous injection, and following prenatal exposure. By inhalation, tumors developed in rats following 1 hour per day exposures to 10 ppm DMS for 130 days.

Special Handling Conditions

The TLV for DMS is 0.1 ppm (0.5 mg/m^3) as an 8-hour time-weighted average. DMS is classified as being suspect of carcinogenic potential in humans by the ACGIH. The OSHA PEL for DMS is 1.0 ppm. These limits include a warning of the potential contribution of skin absorption to the overall exposure.

Procedure A (see Section I.B.8) should be used when handing more than a few grams of DMS in view of its fairly high carcinogenic potency in rats by inhalation and its ability to penetrate the skin. It is particularly important to avoid skin contact by appropriate use of rubber gloves, a rubber apron, and other protective apparel and to avoid inhalation of even low concentrations of vapor by working in a hood.

DIOXANE

CAS Registry No.: 123-91-1

Synonyms: *p*-Dioxane; 1,4-diethylene dioxide; 1,4-dioxane; 1,4-dioxacyclohexane

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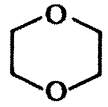
Structure



$C_4H_8O_2$

Physical Properties

Molecular Weight: 88.10
Physical Form: Colorless liquid
Melting Point: 11.8°C
Boiling Point: 101.3°C
Flash Point: 11°C
Specific Gravity (liquid): 1.03 (20°C/4°C)
Vapor Density (air = 1): 3
Vapor Pressure: 37 mm Hg (25°C)
Solubility: Miscible in all proportions with water, acetone, alcohols, and most organic solvents
Odor: Faintly alcoholic; threshold = 5.7 ppm.

Toxicity and Hazard

A worker who was exposed via the skin and inhalation routes to 500 ppm of dioxane for 1 week died. Autopsy revealed damage to the kidney, liver, and brain. Symptoms of inhalation overexposure include irritation of the upper respiratory tract, coughing, eye irritation, vertigo, headache, and vomiting. An airborne concentration of 300 ppm of dioxane causes irritation of the eyes, nose, and throat. At lower levels, exposure sufficient to cause harm can occur before one realizes it through smell or irritation. Prolonged or repeated skin contact can produce drying and fissuring of the skin. Dioxane forms explosive peroxides in contact with air, especially in the presence of moisture.

Dioxane is slightly toxic to animals via the skin: LD_{50} (rabbits) = 7600 mg/kg and has a very low toxicity via the oral route: LD_{50} (rats) = 7120 mg/kg. No skin irritation was seen in rabbits or guinea pigs from a 25% aqueous solution. However, dioxane is irritating to the skin on prolonged or repeated contact. Dioxane caused mild, transient injury in rabbit eyes. It is slightly toxic on inhalation. No serious symptoms were seen in guinea pigs exposed to 2000 ppm for several hours. However, exposure to 30,000 ppm for 3 hours was lethal.

Rats and mice given drinking water containing 5% dioxane for 30-60 days experienced severe liver and kidney damage. Animals exposed to 1000 ppm dioxane in air for 135 exposures also had liver and kidney damage. However, rats exposed to 111 ppm for 2 years experienced no significant adverse effects.

Dioxane is a weak animal carcinogen. Tumors developed in rats and guinea pigs at feeding levels of about 1% in the diet. Rats had nasal and liver tumors, and guinea pigs had gall bladder and liver tumors. In another study, rats receiving 0.1% dioxane in their water for their lifetime were without adverse effects. Rats exposed to 111 ppm of airborne dioxane for 2 years showed no compound-related effects.

Special Handling Provisions

Dioxane is the principal ingredient of Bray's solution (scintillation cocktail), and uninhibited solutions have been known to explode if left for a period of time.

The current TLV for dioxane is 50 ppm (180 mg/m^3) [with a notice (1980) of intended change to 25 ppm] as an 8-hour time-weighted average. The exposure limit is 100 ppm over any 15-min period. The OSHA PEL for dioxane is 100 ppm. These limits include a warning about the potential contribution of skin absorption to the overall exposure. NIOSH has recommended (1977) a ceiling of 1 ppm in any 30-min period.

Although dioxane has caused tumors in animals, these have occurred only by prolonged exposure to very large amounts and, hence, it is considered a carcinogen of such low potency that no special precautions beyond normal good laboratory practice are needed for working with it. Nitrile rubber is the preferred material for gloves and other apparel used to protect against skin contact. The high volatility of the compound requires that all laboratory operations with it be carried out in a hood. Because it is miscible in water, prompt washing is an effective way to remove dioxane that has accidentally contacted the skin.

ETHYLENE DIBROMIDE

CAS Registry No.: 106-93-4

Synonyms: 1,2-Dibromoethane; ethylene bromide; EDB

Structure

$BrCH_2CH_2Br$; $C_2H_4Br_2$

Physical Properties

Molecular Weight: 187.88
Physical Form: Colorless liquid
Melting Point: 9.79°C
Boiling Point: 132°C
Flash Point: Nonflammable
Specific Gravity (liquid): 2.1792 (20°C)
Vapor Density (air = 1): 6.5
Vapor Pressure: 12 mm Hg (25°C) 17.4 mm Hg (30°C)
Solubility: 0.43 g/100 ml water (30°C); miscible with most organic solvents
Odor: Sweet; threshold = 10 ppm

Toxicity and Hazard

The approximate oral lethal dose of EDB for humans is 5 ml. Skin adsorption of EDB can also cause death, and inhalation of the vapor can produce pulmonary edema. EDB can cause severe irritation to all exposed tissues, respiratory tract, skin, and eye. Systemic effects include central nervous system depression, kidney injury, and severe liver necrosis.

Ethylene dibromide is highly toxic to animals via inhalation. The maximum survival exposures of rats to EDB vapors in air are 3000 ppm for 6 min, 400 ppm for 30 min, and 200 ppm for 2 hours. It is moderately toxic via the oral and skin routes: LD_{50} (rats, oral) = 140 mg/kg; LD_{50} (rabbits, skin) = 300 mg/kg. EDB is markedly irritating to skin, and a 10% solution has caused serious but reversible corneal injury in rabbit eyes.

Rats were repeatedly exposed to 50 ppm EDB for 6 months. Half died from pneumonia and upper respiratory tract infections. Slight changes in the liver and kidney were seen.

EDB has induced a high incidence of tumors (squamous-cell carcinomas of the forestomach) in mice and rats following oral administration.

Special Handling Conditions

The 1979 TLV for EDB was 20 ppm (155 mg/m^3) as an 8-hour time-weighted average. The exposure limit is 30 ppm over any 15-min period. These limits included a warning about the potential contribution of skin absorption to the overall exposure. In 1980, the ACGIH put EDB in category A1b (human carcinogen). For this category, there is no assigned TLV, but the ACGIH recommends that those working with A1b carcinogens should be properly equipped to ensure virtually no contact

with the carcinogen. The OSHA PEL for EDB is 20 ppm, and the acceptable maximum peak is 50 ppm for 5 min in any 8-hour time period.

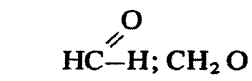
On the basis of the carcinogenicity data for EDB, Procedure A (see Section I.B.8) should be followed when handling more than a few grams in the laboratory. Serious skin injury can occur from direct exposure to EDB. The substance can penetrate neoprene and several other types of plastic; therefore, gloves and other protective apparel of these materials provide only temporary protection if EDB spills on them.

FORMALDEHYDE

CAS Registry No.: 50-00-0

Synonyms: Formalin (this name applies to 30-55% aqueous solutions)

Structure



$HC(=O)H$; CH_2O

Physical Properties

Molecular Weight: 30.03
Physical Form: Colorless gas or aqueous solution or solid polymer (paraformaldehye)
Melting Point: −92°C (gas)
Boiling Point: −19°C (gas); a 37% aqueous solution boils at about 98°C
Flash Points:
37% formaldehyde solution containing
6% methanol 72.2°C (closed cup)
10% methanol 63.8°C (closed cup)
15% methanol 50°C (closed cup)
Explosive limits: 7-73% by volume in air
Specific Gravity (liquid): 0.815 (20°C)
Vapor Density (air = 1): 1.075 (gas)
Vapor Pressure: 10 mm Hg (−88°C) (gas)
Solubility: Very soluble in water; soluble in ether, alcohol, and most organic solvents
Odor: Pungent and irritating; threshold = 1 ppm

Toxicity and Hazard

For humans, an oral dose of 90 ml of 37% formalin (about 520 mg formaldehyde per kg of body weight) is almost certainly fatal within 48

hours. However, 30 ml has been fatal and 120 ml nonfatal in certain cases. Inhalation of vapors may result in severe irritation and edema of the upper respiratory tract, burning and stinging of the eyes, and headache and has been known to cause death. Workers exposed to 2-10 ppm have experienced headaches, nausea, dizziness, and vomiting; lacrimation occurs at 4-5 ppm. For several minutes of exposure, 10 ppm or more is intolerable. Solutions of formaldehyde are irritating to the skin and can cause severe injury if splashed in the eye.

A study of formaldehyde-exposed workers showed an above-average incidence of chronic upper respiratory tract disease. Sensitization of the skin can result from repeated exposure.

Formaldehyde is moderately toxic to animals via inhalation: ALC (rats, 4-hour inhalation) = 250 ppm and is slightly toxic via the oral route: LD_{50} (rats) = 585 mg/kg. Either formaldehyde gas or formalin may cause skin irritation. Formaldehyde is a skin sensitizer. It is a severe eye irritant, causing delayed effects that are not appreciably eased by eye washing.

Rats receiving oral doses of 50, 100, or 150 mg/kg formaldehyde daily for 90 days showed no adverse effects except for a decrease in weight gain at the highest level. Dogs fed 100 mg/kg for 90 days showed a decrease in weight gain, but no other significant effects.

Preliminary data from a study that is still in progress have indicated the development of nasal cancers in rats exposed to 15 ppm formaldehyde for 18 months. In another study, central nervous system effects were seen among rats exposed to 0.8 ppm for 3 months, but not among rats at 0.03 ppm. Mice exposed to 41-163 ppm for up to 64 weeks showed no untoward effects.

Special Handling Conditions

The OSHA PEL for formaldehyde is 3 ppm (4.5 mg/m^3) as an 8-hour time-weighted average, with a 15-min ceiling of 5 ppm and a 10 ppm maximum peak. The TLV is a 2-ppm ceiling limit.

Laboratory operations with formalin in open vessels should be carried out in a hood or other local exhaust device (formaldehyde has such an objectionable odor that there may be little need for this admonition). Because repeated exposure to formaldehyde can lead to a formaldehyde allergy, it is well to avoid skin contact with aqueous solutions by appropriate use of neoprene, butyl rubber, or polyvinyl chloride gloves (see Table 3) and other protective apparel. Splash-proof goggles should be worn if there is any possibility of splashing formaldehyde in the eyes.

If the preliminary indications of carcinogenicity described above are confirmed during completion and assessment of the study, the use of procedure A or B (see Sections I.B.8 and 7, respectively) will be called for.

132 PROCEDURES FOR WORKING WITH CHEMICALS IN LABORATORIES

HYDRAZINE (and its salts)

CAS Registry No.: 302-01-2

Synonyms: None of significance; however, the following forms may be encountered: hydrazine hydrochloride, sulfate, etc.; hydrazine hydrate

Structure

H_2NNH_2 ; N_2H_4

Physical Properties

Molecular Weight: 32.0
Physical Form: Colorless, fuming, oily liquid
Melting Point: 2.0°C
Boiling Point: 113.5°C
Flash Point: 52°C
Explosive Limits: 4.7-100% by volume in air
Specific Gravity (liquid): 1.011 (15°C)
Vapor Density (air = 1): 1.11
Vapor Pressure: 10.4 mm Hg (20°C)
Solubility: Miscible with water and ethanol; insoluble in hydrocarbons
Odor: Ammonialike, fishy; threshold = 3-4 ppm

Toxicity and Hazard

Acute exposure to hydrazine vapors can cause respiratory tract irritation, excitement, convulsions, cyanosis, and a decrease in blood pressure. The liquid can severely burn the eye and skin. Hydrazine can cause fatty degeneration of the liver, nephritis, and hemolysis.

Hydrazine also poses a dangerous fire and explosion risk and can explode during distillation if traces of air are present.

Hydrazine is moderately toxic to animals via the inhalation, oral, and skin routes: LC_{50} (rats, 4-hour inhalation) = 570 ppm; LD_{50} (rats, oral) = 60 mg/kg; LD_{50} (rabbits, skin) = 283 mg/kg (hydrazine hydrate). It is a strong skin and mucous membrane irritant and a strong skin sensitizer. Hydrazine hydrate produced moderately severe irritation when applied to rabbit eyes.

After repeated oral, skin, or injection exposure, the effects noted include weight loss, weakness, vomiting, and convulsions. The chief histological finding is fatty degeneration of the liver. Among guinea pigs and dogs exposed to hydrazine in the air 5-47 times, the dogs showed liver damage,

with lesser damage to the kidneys and lungs, while the guinea pigs had pneumonitis and partial lung collapse.

Hydrazine or hydrazine salts have been shown to be carcinogenic in mice after oral and intraperitoneal administration and in rats following oral dosing. By the oral route, effects were found at doses of 24-36 (mg/kg)/day in mice and 20 (mg/kg)/day in rats. No tumors were observed in Syrian golden hamsters after oral administration. The ACGIH has classified hydrazine as suspect of carcinogenic potential in humans.

Special Handling Conditions

The TLV for hydrazine is 0.1 ppm (0.1 mg/m^3) and the OSHA PEL is 1.0 ppm (1 mg/m^3) as 8-hour time-weighted averages. These limits include a warning about the potential contribution of skin absorption to the overall exposure. NIOSH has (1978) recommended a ceiling limit of 0.03 ppm in any 2-hour period.

When more than a few grams of hydrazine are to be used in the laboratory, Procedure A (see Section I.B.8) should be used because hydrazine is carcinogenic in animal tests, quite volatile, and readily absorbed through the skin. Moreover, it is a serious risk as an acute poison and a skin and eye irritant. Nitrile rubber is recommended for gloves and other protective apparel. Prompt washing with water effectively removes hydrazine from skin that it has splashed on.

Hydrazine should not be used in the vicinity of a flame or under conditions where sparks can occur, as an explosion or fire can result.

HYDROGEN CYANIDE

CAS Registry No.: 74-90-8

Synonyms: Hydrocyanic acid, HCN

Structure

HC≡N; CHN

Physical Properties

Molecular Weight: 27.03
Physical Form: Colorless liquid
Melting Point: −13.4°C
Boiling Point: 25.7°C

Flash Point: −17.8°C (closed cup)
Explosive Limits: 6-41% by volume in air
Specific Gravity (liquid):
99.7% 0.690 (20°C/15.6°C)
96% 0.703 (20°C/15.6°C)
Vapor Density (air = 1): 0.94
Vapor Pressure: 807 mm Hg (27.2°C)
Solubility: Miscible with water; soluble in alcohol and ether
Odor: Sweetish, characteristic; threshold = 2-5 ppm

Toxicity and Hazard

Hydrogen cyanide is among the most toxic and rapidly acting of all known substances. Exposure to high doses may be followed by almost instantaneous collapse, cessation of respiration, and death. At lower dosages, the early symptoms include weakness, headache, confusion, nausea, and vomiting. In humans, the approximate fatal dose is 40 mg via the oral route. Exposure to 3000 ppm HCN is immediately fatal, while 200-480 ppm can be fatal after 30 min. Exposure to 18-36 ppm HCN causes slight symptoms after several hours. The liquid is rapidly absorbed through the skin or the eyes.

Hydrogen cyanide is extremely toxic to animals via the oral and skin routes: oral LD_{50} (mice) = 3.7 mg/kg. However, it has little or no irritant effect on the skin. Hydrogen cyanide in the eye may cause some local irritation, which is of little significance because the attendant absorption may be hazardous to life. Hydrogen cyanide is highly toxic via inhalation: LC_{50} (rats, 5 min) = 503 ppm, and 100 ppm was fatal to rats in 1.5 hours.

No adverse effects were seen in rats fed HCN-fumigated food for 2 years. In this experiment, special feeding jars were designed to reduce volatilization of the HCN, and analysis of the two test diets 3 days after fumigation showed HCN levels of 100 and 300 ppm. Mice, rats, guinea pigs, rabbits, cats, dogs, pigeons, and a monkey were exposed to various concentrations of HCN. No adverse effects were observed in mice exposed to 40 ppm for 7 hours or in rats and mice exposed to 16 ppm for 16 hours. Concentrations of 31.5 ppm were generally safe for most species exposed for a few hours. Dogs subjected repeatedly to 30-min exposures of 45 ppm HCN exhibited cumulative effects, particularly central nervous system lesions, hemorrhages, and vasodilation.

Special Handling Conditions

The OSHA 8-hour PEL for HCN is 10 ppm with a 15-min TWA of 15 ppm. ACGIH has recently proposed that the basis of the 10 ppm TLV be changed from an 8-hour TWA to a ceiling concentration. These limits include a warning against the potential contribution of skin absorption to the overall exposure. In 1976, NIOSH recommended a limit of 4.7 ppm (5 mg/m^3 as CN) determined as a ceiling concentration, based on a 10-min sampling period.

Aside from its high toxicity, HCN has a low flash point and forms an explosive mixture with air over a wide range of concentrations. Moreover, traces of base can cause rapid spontaneous polymerization, sometimes resulting in detonation. Hence, HCN is very dangerous, anyone working with it should wear goggles and impervious gloves, and no one should work alone with it. In cases of overexposure to HCN, quick action is called for in removing the victim from the contaminated area, using amyl nitrite ampules to restore consciousness or, if breathing has stopped, artificial respiration. Medical assistance should be summoned as soon as possible, but the victim should not be left unattended. Speed in providing treatment is of the utmost importance.

(See also Section I.B.7.)

HYDROGEN SULFIDE

CAS Registry No.: 7783-06-4

Structure

HSH; H_2S

Physical Properties

Molecular Weight: 34.08
Physical Form: Colorless gas
Melting Point: −82.9°C
Boiling Point: −61.8°C
Explosive Limits: 4.3-46% by volume in air
Specific Gravity: 1.54
Vapor Density (air = 1): 1.189 (15°C)
Vapor Pressure: 8.77 atm (20°C)
Solubility: 437 ml/100 ml in water (0°C) and 186 ml/100 ml (40°C); also soluble in alcohol and petroleum solvents

Odor: "Rotten egg"; threshold = 0.2-0.003 ppm; odor appears sweet at 30 ppm and above; high concentrations deaden the sense of smell

Toxicity and Hazard

Hydrogen sulfide is extremely dangerous. Human exposure to relatively low concentrations of H_2S has caused corneal damage, headache, sleep disturbances, nausea, weight loss, and other symptoms suggestive of brain damage. Higher concentrations can cause irritation of the lungs and respiratory passages and even pulmonary edema. Exposure to 210 ppm for 20 min has caused unconsciousness, arm cramps, and low blood pressure. Coma may occur within seconds after one or two breaths at high concentrations and be followed rapidly by death. For example, workers exposed to 930 ppm H_2S for less than 1 min died.

Hydrogen sulfide is moderately toxic to animals via the inhalation route: LC_{50} (mice, 1 hour) = 673 ppm; LC_{50} (mice, 7.5 hours) = 140 ppm. Exposure to 10-13 ppm for 4-7 hours has caused eye irritation. Skin absorption of H_2S is slight and not considered significant. However, prolonged or repeated skin contact might cause mild irritation. Guinea pigs that had 0.78 $in.^2$ of their skin exposed to 100% H_2S vapors for 1 hour experienced slight swelling.

Rabbits exposed to 100 ppm H_2S for 30 min/day for 4 months showed changes in the blood (leucopenia and lymphocytosis). Animals continuously exposed for 90 days to 20 ppm exhibited pathologic changes of the lungs.

Special Handling Conditions

The TLV for H_2S is 10 ppm (14 mg/m^3) as an 8-hour time-weighted average. The short-term exposure limit (15 min) is 15 ppm. The OSHA PEL has a ceiling limit of 20 ppm and a peak of 50 ppm over any 10-min period. NIOSH (1977) has recommended a 10-min ceiling of 10 ppm.

Partly because of the disagreeable odor of H_2S, but also because of its toxicity, laboratory operations with it should be carried out in a hood. Cylinders of it should not be stored in small, unventilated rooms, as deaths have resulted from people entering such rooms containing a leaking cylinder.

(See Section I.B.7.)

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METHANOL

CAS Registry No.: 67-56-1

Synonyms: Methyl alcohol, wood alcohol

Structure

CH_3OH; CH_4O

Physical Properties

Molecular Weight: 32.04
Physical Form: Colorless liquid
Freezing Point: −97.8°C
Boiling Point: 65°C
Flash Point: 12°C
Specific Gravity (liquid): 0.7915
Vapor Density (air = 1): 1.11
Vapor Pressure: 95 mm Hg (20°C)
Solubility: Completely miscible with water, ether, and most organic solvents
Odor: Mild, threshold = 3-8 ppm

Toxicity and Hazard

Methanol is well known to cause blindness in humans, but this usually results from drinking large quantities. Once absorbed, methanol is only very slowly eliminated. Severe exposure to the vapors of methanol can cause dizziness, central nervous system depression, shortness of breath, coma, and eventually death. Where the exposure is less severe, the first symptoms may be blurring of vision, photophobia, conjunctivitis, headache, gastrointestinal disturbances, dizziness, and a feeling of intoxication, followed by the development of definite eye lesions.

Methanol has a very low acute toxicity in animals via the inhalation and oral routes: ALC (rats, head only, 1-hour inhalation) > 145,000 ppm; LD_{50} (rats, oral) = 6200 mg/kg. The substance is moderately toxic via the skin: LD_{50} (rabbits) = 14,400 mg/kg. Methanol has caused moderate corneal opacity and conjunctival redness in rabbit eyes.

Methanol has shown a relatively low chronic toxicity in animal studies. For example, no adverse effects were seen in dogs exposed to 450-500 ppm of methanol in the air 8 hours daily for 379 days. Rats given 1% methanol

in their drinking water for 6 months showed no significant effects. However, in another oral study in rats, toxic effects were found in the liver.

Special Handling Conditions

The TLV and the OSHA PEL for methanol are 200 ppm (260 mg/m^3) as an 8-hour time-weighted average. This limit includes a caution against skin contact. The exposure limit is 250 ppm over any 15-min period.

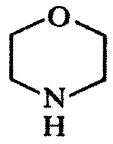
Although methanol is one of the safest solvents, it is best to carry out operations in a hood if significant amounts could escape into the laboratory atmosphere; for example, during recrystallization from boiling methanol in an open flask. If there are opportunities for significant hand contact, neoprene gloves should be worn. If a still safer solvent of similar properties seems called for, ethanol is often a good choice.

MORPHOLINE

CAS Registry No.: 110-91-8

Synonyms: Tetrahydro-1,4-oxazine; tetrahydro-1,4-isoxazine; diethyleneimide oxide

Structure



C_4H_9NO

Physical Properties

Molecular Weight: 87.12
Physical Form: Mobile, hygroscopic liquid
Melting Point: −4.9°C
Boiling Point: 128.9°C
Flash Point: 38°C (open cup)
Explosive Limits: Not defined
Specific Gravity: 1.002 (20°C)
Vapor Density (air = 1): 3.0
Vapor Pressure: 6.6 mm Hg (20°C)
Solubility: Miscible with water and most organic solvents

Toxicity and Hazard

Exposure to the vapors of morpholine can produce irritation of the skin and, if inhaled, the substance can cause irritation of the respiratory tract, similar to that produced by ammonium hydroxide. There can be a burning sensation of the nose and throat and coughing, and blurred vision can result from corneal edema. The liquid is a severe irritant to the skin and can produce ulceration of the conjunctiva.

In laboratory experiments, repeated exposure of rats at high concentrations (18,000 ppm) produced death, with damage to the lung, liver, and kidneys.

Morpholine is a moderate fire hazard when exposed to heat, flames, or oxidizing agents. Decomposition results in generation of oxides of nitrogen.

Special Handling Conditions

OSHA has established an allowable 8-hour time-weighted average exposure to morpholine of 20 ppm. It should be noted that skin contact can be a significant contributor to toxic effects. The ACGIH has established a TLV of 20 ppm for an 8-hour TWA and also a short-term exposure limit of 30 ppm for 15 min.

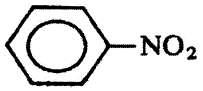
The TLV was established to prevent irritation of the respiratory tract and the effects on the eye.

NITROBENZENE

CAS Registry No.: 98-95-3

Synonyms: Nitrobenzol

Structure



$C_6H_5NO_2$

Physical Properties

Molecular Weight: 123.11
Physical Form: Yellow, oily liquid

Melting Point: 5.7°C
Boiling Point: 211°C
Flash Point: 88°C (closed cup)
Specific Gravity (liquid): 1.19867 (24°C/4°C)
Vapor Density (air = 1): 4.24
Vapor Pressure: 10 mm (85.4°C); 100 mm (139.9°C)
Solubility: 0.2 g/100 ml water (20°C); miscible with most organic solvents
Odor: Oil of bitter almond; threshold = 0.5 ppm

Toxicity and Hazard

The oral lethal dose of nitrobenzene for humans is about 5 mg/kg. No immediate or delayed effects have been seen in humans after 30-60 min of exposure to 200-300 ppm of nitrobenzene. Exposure to 40-80 ppm for several hours, however, will cause slight symptoms. The symptoms of overexposure to nitrobenzene, whether by inhalation or by skin contact, are cyanosis due to methemoglobin formation in the blood, anoxia, weakness, and sometimes shock. Inflammation of the skin is sometimes seen. Absorption through the skin is the greatest hazard in the workplace. Onset of symptoms may be delayed for up to 4 hours.

Nitrobenzene is slightly toxic to animals via the oral route: LD_{50} (rats) = 640 mg/kg. It is moderately toxic via the skin: LD_{50} (rats) = 2100 mg/kg. It is a mild eye irritant.

Nitrobenzene transforms hemoglobin into methemoglobin on oral administration to rats. Rats exposed to about 0.01-0.02 ppm of nitrobenzene for 70-82 days experienced adverse central nervous system effects and inflammation of internal organs. A concentration of 0.0016 ppm in air caused no significant adverse effects in rats during 73 days of constant exposure.

Special Handling Conditions

The TLV and the OSHA PEL for nitrobenzene are 1 ppm (5 mg/m^3) as an 8-hour time-weighted average. These limits include a warning against the potential contribution of skin absorption to the overall exposure. The exposure limit is 2 ppm during any 15-min period.

Nitrobenzene, like most aromatic nitro compounds, readily penetrates the skin to cause the serious toxic effects described above. Hence, anyone using it in the laboratory should take care to avoid skin contact. If more than a few grams are being used, rubber gloves and other protective apparel may be needed. Although nitrobenzene is only moderately volatile, it is advisable to handle it in a hood.

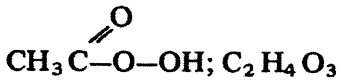
Hazards and Precautions for a Selected Group of Chemicals *141*

PERACETIC ACID

CAS Registry No.: 79-21-0

Synonyms: Peroxyacetic acid, acetyl hydroperoxide

Structure



$CH_3C(=O)-O-OH$; $C_2H_4O_3$

Physical Properties

Molecular Weight: 76.05
Physical Form: Colorless liquid
Available Form: Most commonly, as 40% solution in acetic acid
Melting Point: 0.1°C
Freezing Point: Approximately −30°C
Boiling Point: 105°C
Flash Point: 105°C
Autoexplosion Temperature: 110°C

Toxicity and Hazard

Peracetic acid, like most peracids, is unstable. It has an acrid odor and is very irritating to skin, eyes, and upper respiratory tract. On the basis of animal test data, it is considered highly to moderately toxic by ingestion in single doses.

By oral administration to test animals, peracetic acid is moderately to highly toxic, causing severe irritation of the stomach and intestinal linings. It is moderately toxic by single dermal applications to rabbits. Repeated applications at relatively high dosages to the skin of mice produced skin irritation and indicated that peracetic acid is a potent tumor promotor and a weak carcinogen.

Special Handling Conditions

Because explosion is the greatest hazard of peracetic acid, the substance should be protected from sparks or physical shock and laboratory operations with it should be carried out behind a shield and in a hood that has explosion-proof equipment. Peracetic acid explodes at 100°C and decomposes at lower temperatures with the generation of oxygen. It reacts vigorously with organic materials.

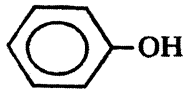
Because of its high irritancy, care should be taken to prevent contact of peracetic acid with the skin, eyes, or upper respiratory tract. This is

another reason why work with it should be carried out in a hood and also means that rubber gloves and a rubber apron should be worn as appropriate.

PHENOL

CAS Registry No.: 108-95-2

Structure



C_6H_5OH

Physical Properties

Molecular Weight: 94.11
Physical Form: Colorless to light pink solid
Melting Point: 41°C
Boiling Point: 182°C
Flash Point: 85°C (open cup)
Specific Gravity (liquid): 1.049 (50°C/4°C)
Vapor Density (air = 1): 3.24
Vapor Pressure: 0.3513 mm Hg (25°C)
Solubility: 6.7 g/100 ml water (16°C); miscible at 66°C; easily soluble in alcohol and other organic solvents
Odor: Characteristically sweet; threshold = 0.3 ppm

Toxicity and Hazard

In humans, lethal oral doses of phenol have ranged from 1 to 10 g. Severe phenol poisoning by ingestion is characterized by burns of the mouth and throat and rapid development of digestive disturbances, headache, fainting, vertigo, mental disturbances, collapse, and coma. Exposure to the vapor can produce marked irritation of the eyes, nose, and throat. Concentrated solutions are corrosive to the eyes and skin. Phenol readily penetrates the skin.

Phenol is moderately toxic to animals via the inhalation and the oral routes: LC_{50} (rats, 1-hour inhalation) = 312 ppm; LD_{50} (rats, oral) = 414 mg/kg. It is also moderately toxic via skin absorption: LD_{50} (rabbits) = 1120 mg/kg. Phenol is corrosive to the eyes and skin and may cause irritant dermatitis.

Guinea pigs were severely injured by inhalation of 25-50 of ppm phenol for 20 days. Damage was seen in the lungs, liver, kidneys, and heart.

Special Handling Conditions

The TLV and the OSHA PEL for phenol are 5 ppm (19 mg/m^3) as an 8-hour time-weighted average. The standard includes a warning about the potential contribution of skin absorption to the overall exposure. The exposure limit is 10 ppm over any 15-min period. NIOSH (1976) has recommended an 8-hour time-weighted average of 5.20 ppm with a limit of 15.6 ppm over any 15-min period.

Because phenol is a potent skin irritant, rubber gloves (see Table 3) should be worn when there is opportunity for significant skin contact.

PHOSGENE

CAS Registry No.: 77-44-5

Synonym; Carbonyl chloride

Structure

ClC–Cl; CCl_2O

Physical Properties

Molecular Weight: 98.92
Physical Form: Colorless gas
Melting Point: −104°C
Boiling Point: 8.3°C
Specific Gravity (liquid): 1.392 (19°C/4°C)
Vapor Density (air = 1): 3.4
Vapor Pressure: 563 mm Hg (0°C); 760 mm Hg (8.3°C); 1418 mm Hg (25°C)
Solubility: Decomposes in water with formation of CO_2 and HCl; soluble in most organic solvents and oils
Odor: Sweet (geraniumlike) at low levels, pungent and irritating at higher levels; threshold = 0.5-1 ppm

Toxicity and Hazard

In humans, the symptoms of overexposure to phosgene are dryness or a burning sensation in the throat, numbness, vomiting, and bronchitis. An

airborne concentration of 5 ppm may cause eye irritation and coughing in a few minutes. The substance can cause severe lung injury in 1-2 min at a level of 20 ppm. Exposure to concentrations above 50 ppm is likely to be fatal.

Phosgene is extremely toxic to animals via inhalation. Thus, 74% of a group of rats died from exposure to 55-100 ppm for only 10 min. Liquid phosgene is likely to cause severe skin burns and eye irritation.

Pulmonary edema, bronchiolitis, and emphysema were found in cats and guinea pigs exposed to 2.5-6.25 ppm of phosgene/day for 2-41 days. A variety of animals exposed to 0.2 or 1.1 ppm for 5 hours per day for 5 days also had pulmonary edema.

Special Handling Conditions

The TLV and the OSHA PEL for phosgene are 0.1 ppm (0.4 mg/m^3) as an 8-hour time-weighted average. NIOSH has recommended a limit of 0.2 ppm over any 15-min period.

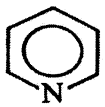
In the laboratory, work with phosgene should always be carried out within a hood. Unused quantities of phosgene greater than 1 g should be destroyed by reaction with water or dilute alkali.

(See Section I.B.7.)

PYRIDINE

CAS Registry No.: 110-86-1

Structure



C_5H_5N

Physical Properties

Molecular Weight: 79.1
Physical Form: Colorless basic liquid
Melting Point: 42.1°C
Boiling Point: 115.6°C
Flash Point: 20.0°C (tag closed cup)
Explosive Limits: 1.8-12.5% by volume in air
Specific Gravity: 0.986 (15.5°C)
Vapor Density (air = 1): 2.73
Vapor Pressure: 20 mm Hg (25°C)

Solubility: Miscible with water and most organic solvents
Odor: Unpleasant; characteristic

Toxicity and Hazard

Acute exposure to pyridine can produce transient headaches, dizziness, or light-headedness. Insomnia, mental dullness, nausea, and anorexia have also been reported. Such effects have been reported in workers exposed to more than 100 ppm on a relatively regular basis. The liquid and vapor are irritating to the eyes, nose, and throat.

Chronic exposure has produced serious liver and kidney damage, with death having occurred once. This exposure was by ingestion, prescribed therapeutically, of about 2 ml/day. There are also reports of central nervous system effects. Continuing skin contact with the liquid can produce a dry, scaly, inflammation.

Special Handling Conditions

Pyridine presents a significant fire hazard when exposed to heat or flame. The danger of explosion is severe if the vapor contacts heat or flame. Pyridine reacts violently with chlorosulfonic acid, chromic acid, maleic anhydride, nitric acid, fuming sulfuric acid, perchromates, β-propiolactone, silver perchlorate, and sulfuric acid. On decomposition, cyanides can be liberated.

The current OSHA PEL for pyridine is 5 ppm as an 8-hour time-weighted average. Although the ACGIH recommends the same 8-hour exposure limit, it also recommends a short-term exposure limit of 10 ppm for 15 min. The odor threshold of approximately 1 ppm requires that pyridine be handled in a laboratory hood or with the use of some other local exhaust ventilation.

SODIUM AZIDE

CAS Registry No.: 26628-22-8

Structure

NaN_3

Physical Properties

Molecular Weight: 65.02
Physical Form: Colorless hexagonal crystals

Melting Point: Decomposes
Density: 1.846

Toxicity and Hazard

Sodium azide is highly toxic to humans. It is highly soluble in water and rapidly converted to hydrazoic acid, which may, therefore, be the ultimate toxic agent in a human exposed to sodium azide.

Acute exposure to hydrazoic acid vapor can produce irritation of the eyes, tracheal bronchitis, headache, possibly a dramatic decrease in blood pressure, weakness, pulmonary edema, and collapse.

Accidental ingestion of 50-60 mg of sodium azide has resulted in brief loss of consciousness, nausea, and severe headache, but recovery was rapid. In another incident, while acidifying 10 g of sodium azide, a chemist complained of dizziness, blurred vision, shortness of breath, and faintness following a few minutes of exposure. Hypotension and bradycardia were seen but, again, recovery was complete in 1 hour.

Acute poisoning in laboratory animals has established that sodium azide is highly toxic via the oral route: LD_{50}, rats = about 45 mg/kg. After a lethal dose, the animals showed respiratory distress and convulsions, followed by nervous system depression and death. After severe poisoning by the azide, rats exhibited lesions in the optic nerves and tracts.

Sodium azide has been used to control blood pressure therapeutically. Doses of 0.65-3.9 mg by mouth daily for up to 2.5 years lowered the blood pressure and reduced the transient pounding sensation of the head with no evidence of organic damage.

It is thought that a TLV of 0.2 mg/m^3 of sodium azide or 0.1 ppm of hydrazoic acid will prevent significant lowering of blood pressure or headache discomfort.

Special Handling Conditions

Sodium azide is one of the azides that is not explosive. It may, however, react violently with benzoyl chloride plus potassium hydroxide, bromine, carbon disulfide, chromium oxychloride, copper, lead, nitric acid, dimethylsulfate, and dibromomalononitrile. It is especially important that sodium azide not be allowed to come in contact with heavy metals (for example, by being poured into a lead or copper drain) or their salts; heavy metal azides detonate with notorious ease.

There is currently no OSHA PEL for sodium azide. The ACGIH recommends that exposure to this compound not exceed 0.1 ppm as an 8-hour time-weighted average. This level is also recommended as a ceiling that should not be exceeded even instantaneously during the day. Use of a

laboratory hood that has a protection factor adequate to prevent significant worker exposure or a closed system is recommended for operations using sodium azide.

SODIUM CYANIDE

CAS Registry No.: 143-33-9

Structure

NaC≡N

Physical Properties

Molecular Weight: 49.02
Physical Form: White solid
Melting Point: 564°C
Boiling Point: 1496°C
Vapor Pressure: 1.0 mm Hg (817°C)
10.0 mm Hg (983°C)
Solubility: Readily soluble in water; slightly soluble in alcohol

Toxicity and Hazard

Sodium cyanide is among the fastest acting of all known poisons. The lethal oral dose for humans is 200 mg. The symptoms of cyanide overdose include weakness, headache, confusion and, occasionally, nausea and vomiting. Higher doses may be followed by almost instantaneous collapse, cessation of respiration, and immediate death. Solutions are irritating to the skin, nose, and eyes, and cyanide is adsorbed through the skin.

Sodium cyanide is highly toxic to animals via the oral route: LD_{50} (rats) = 6.4 mg/kg. It can be corrosive to the skin and the eyes, for it is highly alkaline. Sodium cyanide can also produce toxic symptoms via skin absorption and inhalation.

Special Handling Conditions

The TLV and the OSHA PEL for cyanide are both 5 mg/m^3 as an 8-hour time-weighted average. These limits include a warning of the potential contribution of skin absorption to the overall exposure. In 1976, NIOSH recommended that the 5-mg/m^3 limit be retained but that its basis be changed from an 8-hour TWA to a 10-min ceiling.

Dry cotton gloves should be worn when handling dry sodium cyanide.

Rubber gloves and splash-proof goggles should be worn when substantial amounts of sodium cyanide solution are used.

Acid must not be allowed to come in contact with sodium cyanide, as gaseous hydrogen cyanide will be liberated. (The special problems of hydrogen cyanide are discussed in Section I.B.7, along with safety and first aid measures that mostly apply to sodium cyanide as well.)

Tert-BUTYL HYDROPEROXIDE

CAS Registry No.: 75-91-2

Synonyms: Hydroperoxide, *tert*-butyl, cardox TBH

Structure

$(CH_3)_3C-O-OH$; $C_4H_{10}O_2$

Physical Properties

Molecular Weight: 90.12
Physical Form: Water-white liquid
Melting Point: −8°C
Boiling Point: 35°C
Flash Point: 27°C or above
Specific Gravity: 0.896 (20°C/4°C)
Vapor Density (air = 1): 2.07
Solubility: Moderately soluble in water; very soluble in organic (esters and alcohols) solvents and alkali metal hydroxide solutions

Toxicity and Hazard

There are no reports of acute or chronic effects in humans from exposure to *tert*-butyl hydroperoxide. Experimental studies of this chemical indicate that it will cause severe injury to the eyes and when placed in contact with the skin. It is moderately toxic by inhalation and ingestion and probably can cause irritation of the respiratory tract when inhaled.

The oral LD_{50} in rats is 460 mg/kg, and the LC_{50} (4-hour inhalation) in rats is 500 ppm. The percutaneous LD_{50} in the rat is 790 mg/kg. Five hundred mg of the chemical in contact with rabbit skin for 24 hours produced severe irritation. A 75% solution in dimethyl phthalate and a 35% solution of *tert*-butyl hydroperoxide in propylene glycol caused

severe, permanent damage when applied to rabbit eyes. A 7% solution in propylene glycol caused slight irritation.

Special Handling Conditions

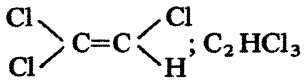
Tert-butyl hydroperoxide is very dangerous when exposed to heat or flame or by spontaneous chemical reaction. Slow first-order decomposition can be accelerated by the presence of 1 mole percent of copper, cobalt, or manganese salts. The substance can also react with reducing agents. There are currently no TLV or OSHA PEL related to this compound.

TRICHLOROETHYLENE

CAS Registry No.: 79-01-6

Synonyms: Triclene; ethene, trichloro

Structure



; C_2HCl_3

Physical Properties

Molecular Weight: 131.4
Physical Form: Colorless liquid
Melting Point: −84.8°C
Boiling Point: 86.7°C
Flash Point: None
Specific Gravity (liquid): 1.456 (25°C/4°C)
Vapor Pressure: 19.9 mm Hg (0°C); 57.8 mm Hg (20°C)
Solubility: 0.105 g/100 ml water (20°C); soluble in ethanol and ethyl ether
Odor: Sweet; threshold = 21.4 ppm

Toxicity and Hazard

In humans, acute exposure to trichloroethylene primarily affects the central nervous system. Common symptoms are headache, dizziness, nausea, fatigue, and drunkenness. Coma and sudden death have been reported in severe intoxication. Exposure for 2 hours to 1000 ppm caused adverse affects to performance of steadiness and manual dexterity tests.

Acute skin exposure has caused erythema, burning, and inflammation of the skin. With repeated exposure, the liquid can produce inflammation and skin vesicles; in the eye, it produces pain and inflammation.

Trichloroethylene has a very low toxicity to animals via the inhalation and the oral routes: LC_{50} (mice, 4-hour inhalation) = 8450 ppm; LD_{50} (rats, oral) = 7.2 g/kg. Skin contact causes only mild irritation unless the affected area is closely occluded; skin absorption is not significant. When instilled into rabbit eyes, trichloroethylene has caused mild to moderate injury.

No significant changes were seen in rats exposed to 2000 ppm trichloroethylene, 5 days per week for 6 months. Female mice, however, exhibited fatty degeneration of the liver after exposure to 1600 ppm for up to 8 weeks. After inhaling 500-750 ppm for 3-8 weeks, dogs exhibited lethargy, anorexia, nausea, vomiting, weight loss, and liver dysfunction.

In a recent National Cancer Institute study, extremely high doses of trichloroethylene were shown to cause liver cancer in mice. There is no evidence that the material causes cancer in humans.

Special Handling Conditions

The TLV for trichloroethylene is 100 ppm (535 mg/m^3) [with a notice (1980) of intended change to 50 ppm] as an 8-hour time-weighted average; the exposure limit is 150 ppm over any 15-min period. The OSHA PEL for trichloroethylene is 100 ppm, with an acceptable ceiling of 200 ppm, and an acceptable maximum peak of 300 ppm for a duration of 5 min in any 2 hours. NIOSH (1973) has recommended an 8-hour time-weighted average of 100 ppm, with a ceiling of 150 ppm in any 10-min period.

Although trichloroethylene has caused cancer in mice, its carcinogenic potency is so low that no special precautions are needed for laboratory work with it beyond normal good practices. This includes the use of a hood for most operations.

VINYL CHLORIDE

CAS Registry No.: 75-01-4

Synonyms: Chloroethylene, chlorethene, VCM

Structure

$CH_2{=}CHCl$; C_2H_3Cl

Physical Properties

Molecular Weight: 62.50
Physical Form: Colorless gas at standard conditions but is usually handled as a liquid (sweet smelling)
Melting Point: −153.7°C
Boiling Point: −13.8°C
Flash Point: −78°C (C.O.C.)
Autoignition Temperature: 472°C
Flammable Limits: 3.6-33% by volume in air
Vapor Density (air = 1): 2.55 (25°C)
Liquid Density: 0.9013 g/ml (25°C)
Vapor Pressure: 2943 mm Hg (25°C)

Toxicity and Hazard

Brief exposure to vinyl chloride can produce dizziness and disorientation. With continued exposure, central nervous system depression can result, but exposure must be high (5000 ppm or more) to produce this effect. Because the gas is an irritant, there may be some coughing, but this effect is not prominent.

Chronic exposure to vinyl chloride at concentrations of 100 ppm or more has produced Raynaud's syndrome, lysis of the distal bones of the fingers, and a fibrosing dermatitis. These effects are probably related to continuous intimate contact with the skin by the substance.

Chronic exposure has also resulted in the production of a liver cancer—angiosarcoma—in about 50 workers worldwide (a relatively rare occurrence). All of these cancers have been produced by relatively high exposures, probably in the hundreds of parts per million range.

Vinyl chloride is flammable when exposed to heat, flame, or oxidizing agents. Large fires of the compound are very difficult to extinguish. Vapors represent a severe explosion hazard. Peroxides can be formed in air on standing and can explode. Phosgene is evolved on decomposition with heat.

Special Handling Conditions

Vinyl chloride is regulated by OSHA (29 CFR 1910.1017) as a human carcinogen. The regulations, which call for more stringent precautions than Procedure A (see Section I.B.8), should be consulted before work with vinyl chloride is begun. The allowable exposure limits are 1 ppm as an 8-hour time-weighted average and 5 ppm as a 15-min ceiling. Contact

with liquid vinyl chloride is prohibited. A monitoring program is required for all vinyl chloride operations. Exposures to vinyl chloride must be controlled by feasible engineering controls or work practices. Use of closed systems or laboratory hoods that have protection factors adequate to prevent significant worker exposure are recommended. Whenever respirators are required, they must be used in accordance with a standard respirator program.

I.E.3 SELECTED BIBLIOGRAPHY—POTENTIAL HAZARDS OF KNOWN CHEMICALS

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different chemicals. Useful as a first pass, but most of the data have not been evaluated by peer review.

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12. *NIOSH OSHA Product Guide to Chemical Hazards*; DHEW (NIOSH): Sept. 1978, Publ. No. 78-210: Presents, in tabular form, health hazards and protection measures for 380 specific chemicals for which there are federal regulations.

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APPENDIX I

EMERGENCY NUMBERS
to Report Exposure and for Further Information

Department of Environmental Health and Safety - YU	(212) 923-0874
Department of Environmental Health and Safety - Einstein	(718) 430-4150
Occupational Health Service - 1894 Eastchester Road -2nd fl	(718) 794-7048
Employee Health Service (BMHC)	(718) 918-3800
Occupational Health Service (Einstein)	(718) 430-3141

APPENDIX J

GLOSSARY of TERMS

APPENDIX J

GLOSSARY of TERMS

ACGIH	American Conference of Governmental Industrial Hygienists. An organization of professionals in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits for chemical substances and physical agent (see TLV). (6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211;[518]661-7881)
Acid	An inorganic or organic compound that 1) reacts with metals to yield hydrogen; 2) reacts with a base to form a salt; 3) dissociates in water to yield hydrogen or hydronium ions; 4) has a pH of less than 7.0; and 5) neutralizes bases or alkaline media. All acids contain hydrogen and turns litmus paper red. They are corrosive to human tissue and are to be handled with care.
Action Level	The exposure level (the material's concentration in air) at which OSHA regulations to protect employees take effect (29 CFR 1910.1001-1047); e.g., workplace air analysis, employee training, medical monitoring, and record keeping. Exposure at or above the action level is termed occupational exposure. Exposure below this level can also be harmful. This level is generally one half the TLV or PEL.
Acute Health Effect	An adverse effect on a human or animal body, with symptoms developing rapidly. See Chronic Health Effect.
Acute Lethality	The death of animals immediately or within 14 days after a single dose of or exposure to a toxic substance.
Acute Toxicity	The adverse (acute) effects resulting from a single dose of or exposure to a material. Ordinarily used to denote effects observed in experimental animals.
Aerosol	A fine aerial (in air or other gas) suspension of liquid (mist, fog) or solid (dust, fume, smoke) particles small enough to stay suspended.

Alkali — Broadly, any compound having highly basic properties; i.e., one that readily ionizes in aqueous solution to yield OH anions, with a pH above 7, and turns litmus paper blue. Alkalies are oxides and hydroxides of certain metals and belong to group IA of the periodic table (Li, Na, K, Rb, Cs, Fr). Ammonia and amines may also be alkaline. Alkalines are caustic and dissolve human tissue. Treat alkali burns by quickly washing the afflicted area with large amounts of water for at least 15 minutes. Common commercial alkalies are sodium carbonate (soda ash), NaOH, lime, lye, potash, caustic soda, KOH, water glass, regular mortar, portland cement, and bicarbonate of soda.

Asphyxiant — A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen). More simple asphyxiants are harmful to the body only when they become so concentrated that they reduce (displace) the available oxygen in the air (normally about 21%) to dangerous levels (18% or lower). Examples of simple asphyxiants are CO2, N2, H2 and He. Chemical asphyxiants like carbon monoxide (CO) reduce the blood's ability to carry oxygen or like cyanide interfere with the body's utilization of oxygen.

Base — Substances that (usually) liberate OH anions when dissolved in water and weaken a strong acid. Bases react with acids to form salts and water. Bases have a pH greater than 7, turn litmus paper blue, and may be corrosive to human tissue. They are also called alkali and caustic. Examples are lye and DRANO.

Boiling Point, BP — The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure so that the liquid rapidly becomes a vapor. Flammable materials with low BPs generally present special fire hazards. e.g., butane, BP = 31° F; gasoline, BP = 100° F. For mixtures, a range of temperatures is given.

Cancer, Carcinoma — A malignant tumor or cancer; a new growth made up of cells that tend to grow rapidly, infiltrate other cells and give rise to metastasis (spreading). Each cancer is believed to originate from a single "transformed" cell that grows (splits) at a fast, abnormally regulated pace, no matter where it occurs in the body. Cancer is the second most common cause of death in the US. The NTP reports that one to two-thirds of cancers are associated with our environment.

Carcinogen — A material that either causes cancer in humans, or, because it causes cancer in animals, is considered capable of causing cancer in humans. Findings are based on the feeding of large quantities of a material to test animals or by the application of concentrated solutions to the animal's skin. A material is considered a carcinogen if 1) the International Agency for Research on Cancer (IARC) has evaluated it and found it to be a carcinogen or potential carcinogen; 2) the National Toxicology Program's (NTP) Annual Report on Carcinogens lists it as a carcinogen or potential carcinogen; 3) OSHA regulates it as a carcinogen; or 4) one positive study has been published. "Selected Carcinogen" is defined in 29 CFR 1910, within OSHA's standard "Occupational Exposure to Hazardous Chemicals in Laboratories," as a substance: a) OSHA regulates as a carcinogen; b) the NTP lists as "Known to be carcinogen;" c) the IARC lists as Group 1, "carcinogenic to humans;" d) the IARC lists as Group 2A or 2B, "reasonably anticipated to be carcinogen," since it causes statistically significant tumor incidence in animals per criteria listed in section 2, paragraph b.

Ceiling Limit, C — The concentration that should not be exceeded during any part of the working exposure. "An employee's exposure [to a hazardous material] shall at no time exceed the ceiling value" (OSHA).

CERCLA — The Comprehensive Environmental Response, Compensation, and Liability Act. The Superfund Law, Public Law PL 96-510, found in 40 CFR 300. The EPA has jurisdiction. Enacted December 11, 1980, and amended thereafter, CERCLA provides for the identification and the cleanup of the hazardous materials that have been released over the land and into the air, waterways, and groundwater. It covers areas affected by newly released materials and older leaking or abandoned dump sites. Report releases of hazardous materials to the National Response Center, (800) 424-8802. CERCLA established the superfund, a trust fund to help pay for the cleanup of hazardous materials sites. The EPA has authority to collect the cleanup costs from those who release the waste material. Cleanup funds come from fines and penalties, from taxes on active disposal sites to finance their monitoring after they are closed. CERCLA is a result of the serious problems that arose from the release of hazardous materials at the Love Canal area near Niagara Falls, NY, in August 1978.

CFR — Code of Federal Regulations. A collection of the regulations established by law. Contact the agency that issued the regulation for details, interpretations, etc. Copies are sold by the Superintendent of Documents, Government Printing Office, Washington, DC 20402; (202)783-3238.

Chemical Hygiene Officer — Per 29 CFR 1910; OSHA regulation, "Occupational Exposure to Hazardous Chemicals in Laboratories." The designated, qualified employee who assists in the development and implementation of the CHP. See CHP.

CHP, Chemical Hygiene Plan — Per 29 CFR 1910, OSHA standard; "Occupational Exposures to Hazardous Chemicals in Laboratories." Effective 5/1/90. A written plan that includes specific work practices, standard operating procedures, equipment, engineering controls, and policies to ensure that employees are protected from hazardous exposure levels to all potentially hazardous chemicals in use in their work area. This OSHA standard provides for training, employee access to information, medical consultations, examinations, hazard identification procedures, respirator use, and record keeping practices. See paragraph E of the Standard.

Chronic Health Effect — An adverse effect on a human or animal body with symptoms that develop slowly over a long period of time or that recur frequently.

Chronic Toxicity — Adverse (chronic) effects resulting from repeated doses of or exposures to a material over a relatively prolonged period of time. Ordinarily used to denote effects noted in experimental animals.

Combustible — A term the NFPA, DOT, and others use to classify certain materials with low flash points that ignite easily. Both NFPA and DOT generally define combustible liquids as having a flash point of 100° F (38° C) or higher. Nonliquid materials such as wood and paper are classified as ordinary combustibles by the NFPA. OSHA defines combustible liquid within the Hazard Communication Law as any liquid having a flash point at or above 100° F (38° C) but below 200° F (93.3° C).

Contact Hazard — Adverse effects may occur, if there is skin exposure to a material.

Corrosive — A chemical that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact; a liquid that causes a severe corrosion rate in steel. A waste that exhibits a "characteristic of corrosivity (40 CFR 261.22)," as defined by RCRA, may be regulated by EPA as a hazardous waste.

Density	Ratio of weight (mass) to volume of a material, usually in grams per cubic centimeter or pounds per gallon. One cc of H2O weighs 1 g.
Embryotoxin	A material harmful to a developing embryo at a concentration that has no adverse effect on the pregnant female.
EPA, (US) Environmental Protection Agency	A Federal agency with environmental protection regulatory and enforcement authority. Administers the CAA, CWA, RCRA, TSCA, and other Federal environmental laws. (400 M Street, SW, Washington, DC 20460; [202]382- 2090
Epidemiology	The study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (by age, sex, or occupation) may provide information about the causes of the disease.
Evaporation Rate	The rate at which a material vaporizes (volatilizes, evaporates) from the liquid or solid state when compared to a known material's vaporization rate. The evaporation rate can be useful in evaluating a material's health and fire hazards. The known material is usually normal butyl acetate (N-BuAc or n- BuAc), with a vaporization rate designated as 1.0. Vaporization rates of other solvents or materials are then classified as 1) FAST evaporating if greater than 3.0, e.g., methylethyl ketone (MEK), 3.8; acetone, 5.6; hexane, 8.3; 2) MEDIUM evaporating if 0.8 to 3.0, e.g., 190-proof (95%) ethyl alcohol, 114; VM&P naphtha, 1.4; MIBK 1.6; 3) SLOW evaporating if less than 0.8, e.g., xylene, 0.6; isobutyl alcohol, 0.6; normal butyl alcohol, 0.4; water, 0.3; mineral spirits, 0.1.
Explosive	A material that produces a sudden almost instantaneous release of pressure, gas and heat when subjected to abrupt shock, pressure or high temperature.
Exposure Limits	The concentration in workplace air of a chemical thought acceptable. this means that most workers can be exposed at the given levels or lower without harmful effects. The exposure limits in common use are 1) TLV-TWA (threshold limit value - time-weighted average); 2) STEL (short-term exposure limit) or STEL (short-term exposure limit) or STEV (short-term exposure value); 3) C (ceiling value), and; 4) PEL, OSHA's permissible exposure limit.
Flammable Gas	A gas that at ambient temperature and pressure forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that at ambient temperature and pressure forms a range of flammable mixtures with air greater than 12% by volume, regardless of the lower limit.
Flammable Limits (Flammability Limits, Explosive Limits)	The minimum and maximum concentrations of a flammable gas or vapor between which ignition can occur. Concentrations below the lower flammable limit (LFL) are too lean to burn, while concentrations above the upper flammable limit (UFL) are too rich. All concentrations between LFL and UFL are in the flammable range, and special precautions are needed to prevent ignition or explosion.
Flammable Liquid	A liquid that gives off vapors readily ignitable at room temperature. Defined by the NFPA and DOT as a liquid with a flash point below 100° F (38° C).
Flash Point, FP	The lowest temperature at which a flammable liquid gives off sufficient vapor to form an ignitable mixture with air near its surface or within a vessel. Combustion does not continue. FP is determined by tests in cups.
Gavage	Feeding by means of a stomach tube.

General Ventilation — Also known as dilution ventilation. The removal of contaminated air and its replacement with clean air from the general workplace area as opposed to local ventilation, which is specific air changing in the immediate air of a contamination source. An example of local ventilation is a laboratory fume hood.

Hazard Communication Rule — See OSH Act. Requires chemical manufacturers and importers to assess the hazards associated with the materials in their workplace (29 CFR 1910.1200). Material safety data sheets, labeling and training are all results of this law. You are urged to acquire and become familiar with these regulations.

Hazardous Chemical, Material — In a broad sense, any substance or mixture of substances having properties capable of producing adverse effects on the health or safety of a human. In 1971 OSHA adopted the following definition in regulations affecting employers in operations subject to the Federal Longshoremen's and Harbor Worker's Compensation Act. "The term Hazardous Material means a material which has one or more of the following characteristics: 1) Has a flash point below 140° F, closed cup, or is subject to spontaneous heating; 2) Has a threshold limit value below 500 ppm for gases and vapors, below 500 mg/m3 for fumes, and below 25 mppcf (million particles per cubic foot) for dusts; 3) Has a single dose oral LD50 below 50 mg/kg; 4) Is subject to polymerization with the release of large amounts of energy; 5) Is a strong oxidizing or reducing agent; 6) Causes first-degree burns to skin [from a] short time exposure, or is systemically toxic by skin contact; or 7) In the course of normal operations, may produce dusts, gases, fumes, vapors, mists, or smokes which have one or more of the above characteristics. " Also included are substances that are carcinogens, toxic, irritants, corrosives, sensitizers, and agents which damage the lungs, skin, eyes or mucous membranes.

HEPA — High-efficiency particulate air filter. Also called "absolute." Has a 99.97% removal efficiency for .03 micron particles.

IARC — International Agency for Research on Cancer. One of the three sources that OSHA refers to for data on a material's carcinogenicity. (World Health Organization, Geneva, Switzerland; distributed in the USA from 49 Sheridan Avenue, Albany, NY 12210 [518]436-9686)

IDLH — Immediately dangerous to life and health. Used to determine selection of a respirator. The maximum concentration from which one could escape within 30 min. without any escape-impairing symptoms or irreversible health effects. Also, IDLH conditions and conditions that would lead to an IDLH exposure.

Ignition Temperature — The lowest temperature at which a combustible material ignites in air and continues to burn independently of the source of heat.

Incompatible — Describes materials that could cause dangerous reactions and the release of energy from direct contact with one another.

Inflammable — Capable of being easily set on fire and continuing to burn, especially violently.

Inorganic Materials — Compounds derived from other than vegetable or animal sources that do not generally contain carbon atoms. Some simple carbon compounds are considered inorganic (i.e., carbides, COx, carbonates, CS2).

Irritant — A noncorrosive material that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact as a function of concentration or duration of exposure.

Label	Any written, printed, or graphic sign or symbol displayed on or affixed to containers of hazardous chemicals. A label should identify the hazardous material, appropriate hazard warnings, and name and address of the chemical manufacturer, importer, or other responsible party.
Laboratory	Per 29 CFR 1910. A facility where the "laboratory use of hazardous chemicals" occurs, where relatively small quantities of hazardous chemicals are used on a non-production basis.
Laboratory Scale (activity)	The work involves containers of substances used for reactions and transfers that are designed for easy and safe handling by one person. Workplaces that produce commercial quantities of materials are excluded from the definition of "Laboratory."
Laboratory-type Hood	Lab device enclosed on five sides with a movable sash or fixed access port on the sixth side. In operation it draws and then exhausts air from the lab to prevent or minimize the escape of air contaminants. It enables materials to be manipulated within the hood by the employees hands and arms only. Walk-in hoods are permitted if airflow and exhaust remove contaminants and the employee is not within the enclosure when contaminants are released.
LD50	Lethal dose 50. The single dose of a substance that caused the death of 50% of an animal population from exposure to the substance by any route other than inhalation. Other lethal dose percentages, such as LD1, LD10, LD30, and LD99, may be in the scientific literature. LD50 is usually expressed as milligrams or grams of material per kilogram of animal weight (mg/kg or g/kg, where 5000 mg = 5 g = 1 teaspoonful).
Local Ventilation	The drawing off and replacement of contaminated air directly from its source. This type of ventilation is recommended for hazardous airborne materials.
Lower Explosive Limit, Lower Flammable Limit	Refers to the lowest concentration of gas or vapor (% by volume in air) that burns or explodes if an ignition source is present at ambient temperatures. The LEL is constant up to 250° F. Decrease it by 0.7 at temperatures above 250° F because explosibility increases with higher temperature. See Flammable Limits.
mg/m3	Milligrams per cubic meter of air. mg/m3 = ppm x MW divided by 24.45.
MSDS	Material safety data sheet. OSHA has established guidelines for the descriptive data that should be concisely provided on a data sheet to serve as the basis for written hazard communication programs. The thrust of the law is to have those who make, distribute, and use hazardous materials be responsible for effective communication. See the Hazard Communication Rule, 29 CFR, Part 1910. 1200, as amended, Section g.
Neoplasm	A new or abnormal tissue growth that is uncontrollable and progressive.
Nephrotoxic	Poisonous to the kidney.
Neutralize	To render chemically harmless; to return the pH to the neutral level of 7 by adding acid (base) to a basic (acidic) compound.

NFPA	National Fire Protection Association. An international voluntary membership organization to promote/improve fire protection and prevention and establish safeguards against loss of life and property by fire. Best known for the National Fire Codes, 16 volumes of standards, recommended practices, and manuals developed (and periodically updated) by NFPA committees. NFPA 704M publication is the code for showing hazards of materials using the familiar diamond-shaped label with appropriate numbers or symbols (NFPA hazard rating). See Fire Diamond. (Batterymarch Park, Quincy, MA 02269; (800)344-3555, [617]770-3000)
NTP	National Toxicology Program. Federal activity overseen by the Department of Health and Human Services with resources from National Institutes of Health, the Food and Drug Administration, and the Center for Disease Control. Its goals are to develop tests useful for public health regulations of toxic chemicals, to develop toxicological profiles of materials, to foster testing of materials, and to communicate the results for use by others. (NTP Information Office, MD B2-04, Box 12233, Research Triangle Park, NC 27709)
Odor Threshold	The lowest concentration of a material's vapor (or a gas) in air that is detectable by odor.
Organic Materials	Compounds composed of carbon, hydrogen, and other elements with chain or ring structures.
Organic Peroxide	A compound containing the bivalent - O - O - structure and which is a structural derivative of hydrogen peroxide (H2O2) where one or both hydrogen atoms has been replaced by an organic radical.
OSHA	The Occupational Safety and Health Administration. Part of the US Department of Labor. The regulatory and enforcement agency for safety and health in most US industrial sectors. (Documents are available from the OSHA Technical Data Center Docket Office, Rm N-3670, 200 Constitution Ave., NW, Washington, DC 20210; [202]523-7894.)
OSHA Act	The Occupational Safety and Health Act of 1970. Effective April 28, 1971. Public Law 91-596. Found at 29 Cfr 1910, 1915, 1918, 1926. OSHA jurisdiction. The regulatory vehicle to ensure the safety and health of workers in firms larger than 10 employees. Its goal is to set standards of safety that prevent injury and illness among the workers. Regulating employee exposure and informing employees of the dangers of materials are key factors. This act established the Hazard Communication Rule (29 CFR 1910.1200). See Hazard Communications Rule for details.
Oxidizing Agent	A chemical or substance that brings about an oxidation reaction. The agent may 1) provide the oxygen to the substance being oxidized (in which case the agent has to be oxygen or contain oxygen), or 2) receive electrons being transferred from the substance undergoing oxidation. (Chlorine is a good oxidizing agent for electron-transfer purposes, even though it contains no oxygen.)
PEL	Permissible exposure limit. Established by OSHA. This may be expressed as a time-weighted average (TWA) limit or as a ceiling exposure limit that legally must never be exceeded instantaneously even if the TWA exposure limit is not violated. OSHA PELs have the force of law. Note that ACGIH TLVs and NIOSH RELs are recommended exposure limits that may or may not be enacted into law by OSHA.

Personal Hygiene	Precautionary measures taken to maintain good health when exposed to potentially harmful materials. This includes keeping hands, other parts of the body, work clothing, and equipment free of a materials's residue, as well as not eating, drinking, applying makeup, or using toilet facilities where it is in use.
Physical Hazard	A substance for which there is valid evidence that it is a combustible liquid, compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.
PPE	Personal protective equipment. Devices or clothing worn to help insulate a worker from direct exposure to hazardous materials. Examples include gloves and respirators.
ppm	Parts per million. "Parts of vapor or gas per million parts of contaminated air by volume at 25° C and 1 torr pressure " (ACGIH). ppm = (mg/m3) x 24.45 divided by MW.
RCRA	Resource Conservation and Recovery Act, PL 94-580. Found at 40 CFR 240-271. EPA has jurisdiction. Enacted Nov. 21, 1976, and amended since. RCRA's major emphasis is the control of hazardous waste disposal. It controls all solid waste disposal and encourages recycling and alternative energy sources. In 1984 the USA generated 265 million tons of hazardous waste.
RCRA Hazardous Waste	A material designated by RCRA as hazardous waste and assigned a number to be used in record keeping and reporting compliance (e.g., D003, F001, U169).
Reactive Material	A chemical substance or mixture that vigorously polymerizes, decomposes, condenses, or becomes self-reactive due to shock, pressure, or temperature. Includes materials or mixtures that fall within any of these categories: 1) explosive material - a substance or mixture that causes sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden adverse conditions; 2) organic peroxide - an organic compound that contains the bivalent - 0 - 0 - structure, which can be considered a structural derivative of hydrogen peroxide, in which one or both of the hydrogen atoms has been replaced by an organic radical; 3) pressure-generating material - a substance or mixture that may spontaneously polymerize with an increase in pressure unless protected by the addition of an inhibitor or by refrigeration or other thermal control; decompose to release gas in its container, or comprise the contents of a self-pressurized container; 4) water-reactive material - a substance or mixture that reacts with water to release heat or a flammable, toxic gas.
Reproductive Health Hazard/Toxin	Any agent that has a harmful effect on the adult male or female reproductive system or the developing fetus or child. Such hazards affect people in several ways, including loss of sexual drive, mental disorders, impotence, infertility, sterility, mutagenic effects on germ cells, teratogenic effects on the fetus, and transplacental carcinogenesis.
Respirator	Any of a variety of devices that limit inhalation of toxic materials. They range from disposable dust masks to self-contained breathing apparatus (SCBA). All have specific uses and limitations. Their use is covered by OSHA, 29 CFR 1910.134.
Respiratory System	The breathing system, including the lungs and air passages (trachea or windpipe. larynx, mouth, and nose), as well as the associated system of nerves and circulatory supply.

Routes of Entry	To do bodily damage, a material must contact the body. The method of bodily contact is called the route of entry. The routes of entry are 1) absorption (eye or skin contact); 2) ingestion; and 3) inhalation.
SCBA/SCBAF	Self-contained breathing apparatus. Breathing apparatus with full facepiece and an independent supply of air or oxygen.
Sensitizer	A material that on first exposure causes little or no reaction in man or test animals, but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form. Respiratory sensitization to a few chemicals is also known to occur.
Solvent	A material that can dissolve (reduce to molecular form) other materials to form a uniform mixture. Water can be a solvent.
Target Organ Effects	Chemically caused effects from exposure to a material on specifically listed organs and systems such as the liver, kidneys, nervous system, lungs, skin, and eyes.
TLV	Threshold limit value. A term used by ACGIH to express the airborne concentration of a material to which nearly all workers can be exposed day after day without adverse effects. "Workers" means healthy individuals. The young, old, ill, or naturally susceptible will have lower tolerances and need to take additional precautions. ACGIH expresses TLVs in three ways: TLV-TWA, the allowable time-weighted average concentration for a normal 8-hour workday or 40-hour week; TLV-STEL, the short-term exposure limit or maximum concentration for a continuous exposure period of 15 min. (with a maximum of four such periods per day, with at least 60 min. between exposure periods, and provided that the daily TLV-TWA is not exceeded); ceiling (C) the concentration that should not be exceeded at any time.
Toxic	Describes a material's ability to injure biological tissue. Having 1) an LD50 of 50 to 500 mg/kg when administered orally to albino rats weighing 200 to 300 g each; 2) an LD50 of 200 to 1000 mg/kg when administered by continuous contact for 24 hours to the bare skin of albino rabbits weighing 2 to 3 kg each; or 3) an LC50 of 200 to 2000 ppm (gas or vapor) or 2 to 20 mg/l (mist, fume, or dust) when administered by continuous inhalation for 1 hour to albino rats weighing 200 to 300 g each.
Toxic Substance	Any chemical or material that produces any reversible or irreversible effects on the body via any route. These effects include irritation, mutation, reproductive effects, tumorigenesis, organ or functional system effects, or death. The NIOSH Registry of Toxic Effects of Chemical Substances (RTECS) attempts to identify "all known toxic substances" existing in the environment that have documented potential for harm if misused.
Unstable	Tending toward decomposition or other unwanted chemical change during normal handling or storage. An unstable chemical in its pure state, or as commonly produced or transported, polymerizes vigorously, decomposes, condenses, or becomes self-reactive under conditions of shock, pressure or temperature.
Upper Explosive Limit, Upper Flammable Limit	UEL, UFL. The highest concentration of a material in air that produces an explosion in fire or ignites when it contacts an ignition source (high heat, electric arc, spark, or flame). A higher concentration of the material in a smaller percentage of concentration of air may be too rich to be ignited.

Vapor — The gaseous state of a material suspended in air that would be a liquid or solid under ordinary conditions.

Vapor Pressure — The pressure exerted by a saturated vapor above its own liquid in a closed container. Vapor pressures reported on MSDSs are in millimeters of mercury (mm Hg) at 69° F (20° C), unless stated otherwise. Three facts are important to remember: 1) vapor pressure of a substance at 100° F (38° C) is always higher than the vapor pressure of the substance at 68° F (20° C), 2) vapor pressures reported on MSDSs in mm Hg are usually very low pressures: 760 mm Hg is equivalent to 14.7 lb/in.2, and 3) the lower the boiling point of a substance, the higher its vapor pressure. Vapor pressures are useful (with evaporation rates) in learning how quickly a material becomes airborne within the workplace and thus how quickly a worker is exposed to it.

Z List — OSHA's Toxic and Hazardous Substances Tables Z-1-A, Z-2, and Z-3 of air contaminants, found in 29 CFR 1910.1000. These tables record PELs, TWAs, and ceiling concentrations for the materials listed. Any material found on these tables is considered hazardous.

APPENDIX K

SITE MAPS of:

JACK and PEARL RESNICK CAMPUS

ALBERT EINSTEIN COLLEGE of MEDICINE
FERKAUF GRADUATE SCHOOL of PSYCHOLOGY
BRONX, NY

BROOKDALE CENTER

BENJAMIN N. CARDOZO SCHOOL of LAW
NEW YORK, NY

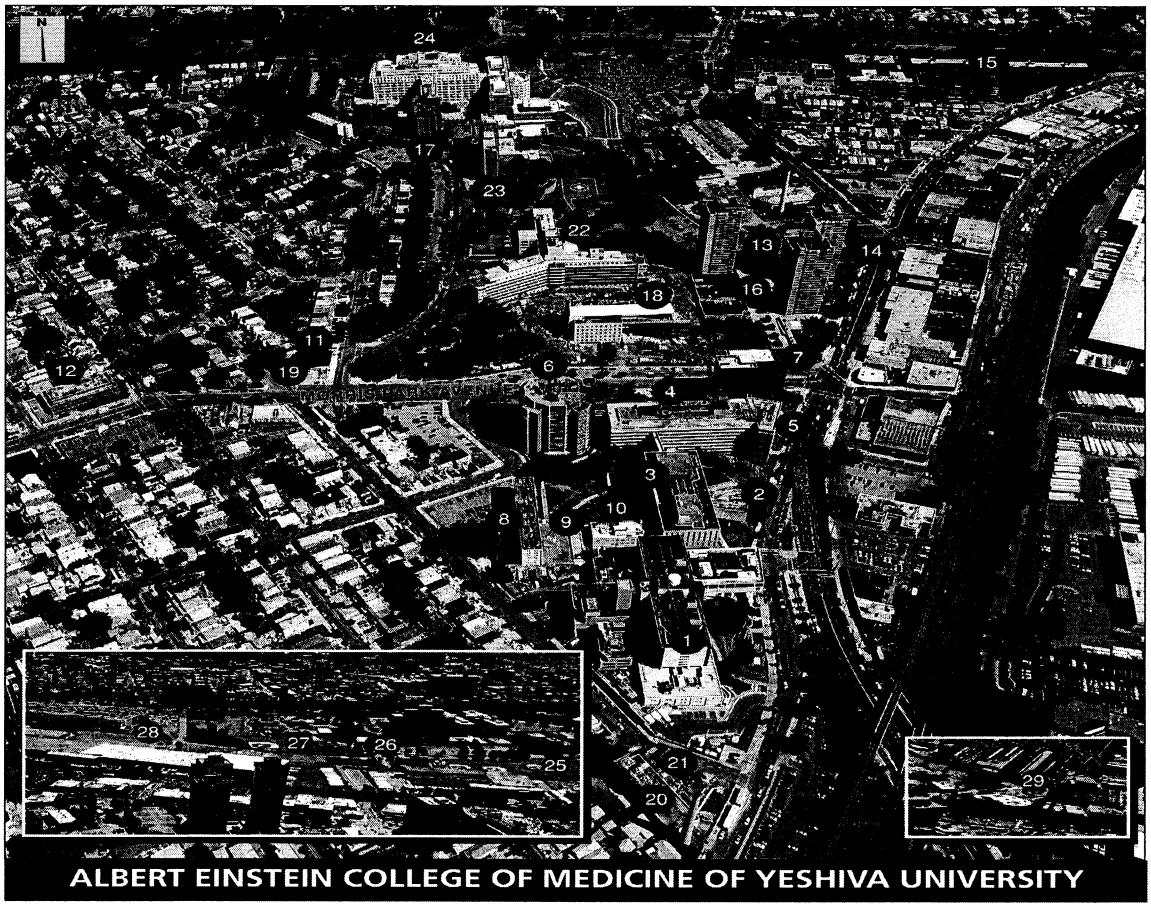
ISRAEL HENRY BEREN CAMPUS

STERN COLLEGE for WOMEN
SY SYMMS SCHOOL of BUSINESS
AZRIELI GRADUATE SCHOOL of JEWISH EDUCATION and ADMINISTRATION

WILF CAMPUS

YESHIVA COLLEGE
SY SYMMS SCHOOL of BUSINESS
BERNARD REVEL GRADUATE SCHOOL of JEWISH STUDIES
WURZWEILER SCHOOL of SOCIAL WORK
AZRIELI GRADUATE SCHOOL of JEWISH EDUCATION and ADMINISTRATION
RABBI ISAAC ELCHANAN THEOLOGICAL SEMINARY
PHILIP and SARAH BELZ SCHOOL of JEWISH MUSIC
YESHIVA UNIVERSITY HIGH SCHOOLS
THE MARSH STEIN TALMUDICAL ACADEMY for BOYS

CHEMICAL HYGIENE PLAN



JACK AND PEARL RESNICK CAMPUS

1. Weiler Hospital ..... *1811 Eastchester Rd. (AKA 1825 Eastchester Rd.)*
2. Robbins Auditorium ..... *1855 Eastchester Rd.*
3. Chanin Institute for Cancer Research ..... *1845 Eastchester Rd.*
4. Forchheimer Medical Science Building, Gottesman Library, Friedman Lounge ..... *1300 Morris Park Ave.*
5. Golding Building ..... *1859 Eastchester Rd.*
6. Ullmann Research Center for Health Sciences ..... *1250 Morris Park Ave.*
7. Belfer Educational Center for Health Sciences ..... *1865 Eastchester Rd.*
8. Mazer Building ..... *1200 Van Nest Ave., 1650 Tenbroeck Ave.*
9. Lubin Dining Hall, Singer Faculty Club ..... *1200 Van Nest Ave.*
10. Gruss Magnetic Resonance Research Center ..... *1300A Morris Park Ave.*
11. Early Childhood Center ..... *1731 Seminole Ave.*
12. Rousso Building ..... *1165 Morris Park Ave.*
13. Eastchester Road Residence Complex ..... *1925-35-45 Eastchester Rd.*
14. Kinney Parking Garage ..... *1975 Eastchester Rd.*
15. Rhinelander Hall Residence Complex ..... *1579 Rhinelander Avenue*
16. Falk Recreation Center ..... *1915 Eastchester Rd.*
17. Rose F. Kennedy Center ..... *1910 Seminole Ave. (AKA 1410 Pelham Pkwy. So.)*
18. The Michael F. Price Center for Genetic and Translational Medicine/ Harold and Muriel Block Pavilion ..... *1301 Morris Park Ave.*
19. MRI Center ..... *1201-11 Morris Park Ave.*
20. AECOM Boiler Plant ..... *1199 Sackett Ave.*
21. Maintenance Garage/Parking Lot ..... *1844 Eastchester Rd., 1846-52 Eastchester Rd.*

JACOBI MEDICAL CENTER

22. Jacobi Ambulatory Care Pavilion – Van Etten .... *1225 Morris Park Ave.*
23. Nurses' Residence ..... *1400 Pelham Pkwy. So.*
24. Jacobi Medical Center ..... *1400 Pelham Pkwy. So.*

BRONX STATE CAMPUS

25. DOSA Trailers ..... *1500 Waters Place (New Bldg. w/b 1510 Waters Place)*
26. Bronx Psychiatric Center ..... *1500 Waters Place*
27. Bronx Children's Psychiatric Center ..... *1000 Waters Place*
28. Metro Center ..... *1200 Waters Place*

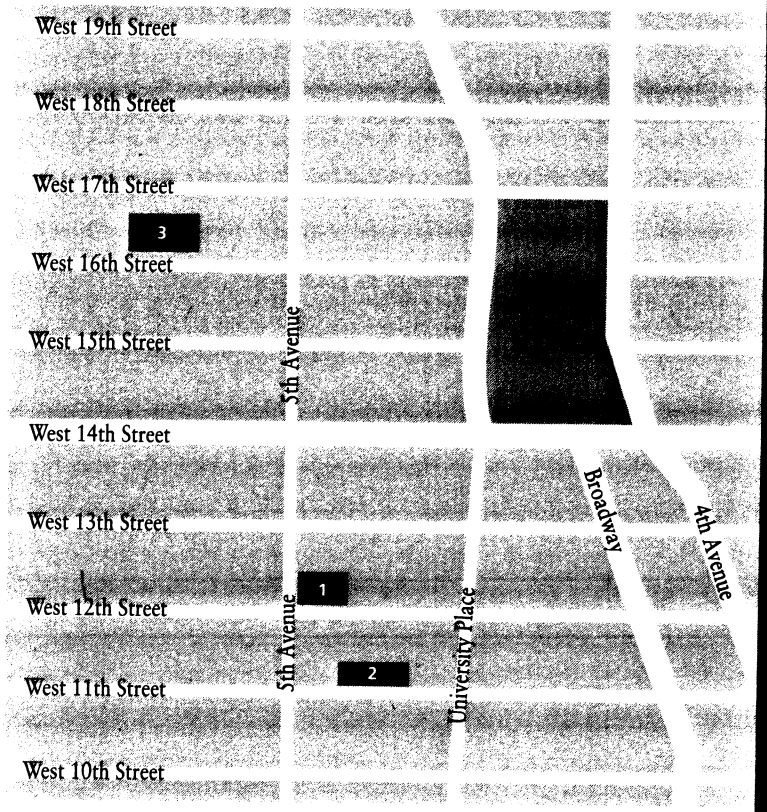
29. MONTEFIORE MEDICAL PARK – AECOM PROGRAM LOCATIONS

Glass Building – OB/Gyn Private Practice ..... *1695 Eastchester Road*
Nuclear Medicine ..... *1525 Blondell Avenue*
Early Childhood Office ..... *1621 Jarrett Place*
Dr. Shamoon ..... *1575 Blondell Avenue*
Dr. Angeletti ..... *1635 Poplar Street*

EINSTEIN
Albert Einstein College of Medicine
OF YESHIVA UNIVERSITY

Brookdale Center

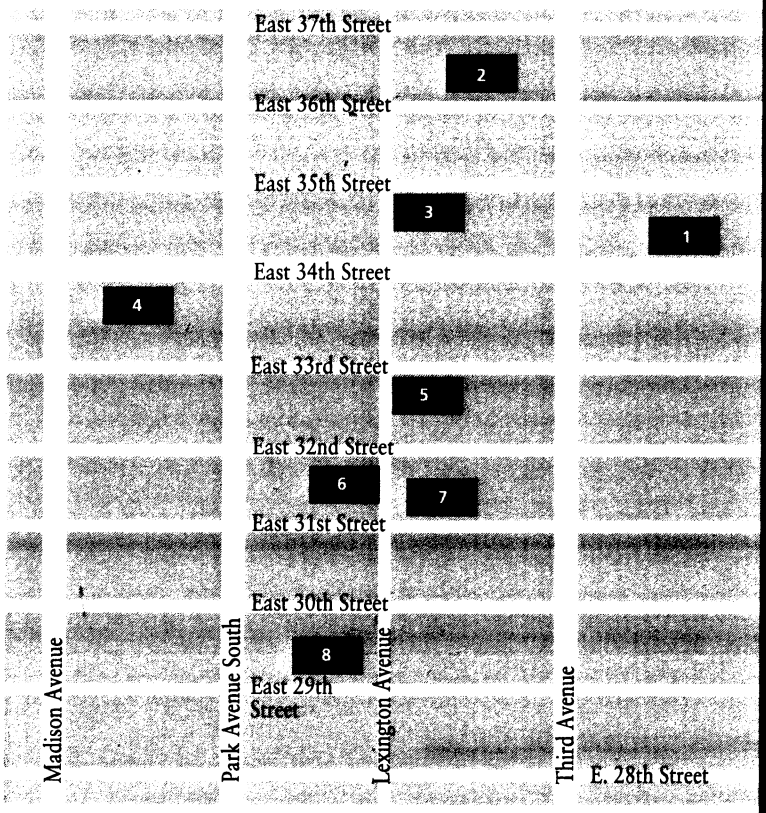
BENJAMIN N. CARDOZO SCHOOL OF LAW



1. **Benjamin N. Cardozo School of Law/Brookdale Center (55 Fifth Avenue)**
2. **Cardozo Student Residence (15 East 11th Street)**
3. **Yeshiva University Museum (15 West 16th Street)**

Israel Henry Beren Campus

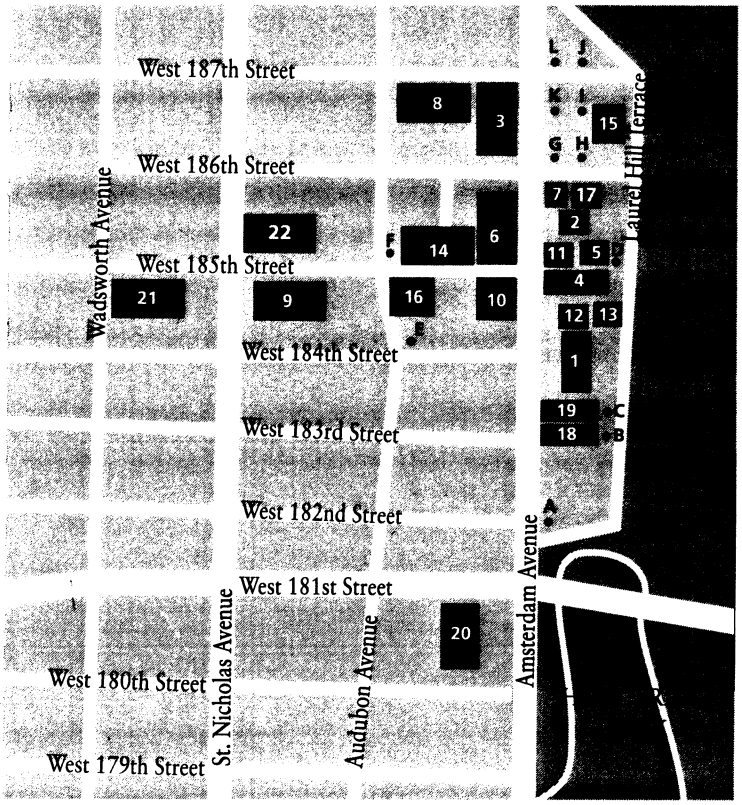
STERN COLLEGE FOR WOMEN
SY SYMS SCHOOL OF BUSINESS
AZRIELI GRADUATE SCHOOL OF JEWISH EDUCATION AND ADMINISTRATION



1. **Geraldine Schottenstein Cultural Center (239–241 East 34th Street)**
2. **36th Street Residence Hall (151 East 36th Street)**
3. **245/253 Lexington Avenue**
   - **Seryl and Charles Kushner Dining Hall**
4. **Brookdale Residence Hall (50 East 34th Street)**
5. **215 Lexington Avenue**
6. **Lexington Plaza (Independent Housing, 184 Lexington Avenue)**
7. **Windsor Court (Independent Housing, 151–155 East 31st Street)**
8. **Jerome and Geraldine Schottenstein Residence Hall (119–121 East 29th Street)**

Wilf Campus

YESHIVA COLLEGE • SY SYMS SCHOOL OF BUSINESS • BERNARD REVEL GRADUATE SCHOOL OF JEWISH STUDIES • WURZWEILER SCHOOL OF SOCIAL WORK • AZRIELI GRADUATE SCHOOL OF JEWISH EDUCATION AND ADMINISTRATION • RABBI ISAAC ELCHANAN THEOLOGICAL SEMINARY • PHILIP AND SARAH BELZ SCHOOL OF JEWISH MUSIC • YESHIVA UNIVERSITY HIGH SCHOOLS—THE MARSHA STERN TALMUDICAL ACADEMY FOR BOYS



1. Belfer Hall
   - Gloria and Jesse Weissberg Commons
2. Joseph and Dora Strenger Residence Hall
3. David H. Zysman Hall
   - Nathan Lamport Auditorium
4. Leah and Joseph Rubin Residence Hall
   - Furman Dining Hall
5. Max Stern Athletic Center, Benjamin Gottesman Pool
6. Mendel Gottesman Library
7. Morris and Celia Morgenstern Residence Hall
8. Ruth and Hyman Muss Residence Hall
9. Schottenstein Center
   - Philip and Sarah Belz School of Jewish Music
10. Sol and Hilda Furst Hall
11. Danciger Quadrangle
12. Herbert and Florence Tenzer Garden
13. Benefactors Wall
14. Jacob and Dreizel Glueck Center for Jewish Study (under construction)
15. Student Support Services

16–23. YU Parking

- 16. Lot A
- 17. Lot B
- 18. Lot C
- 19. Lot D
- 20. Lot E
- 21. Lot F
- 22. Lot G
- 23. Lot H

Independent Housing Program

- A – 497 W. 182 St
- B, C, D – 24, 36, 90, Laurel Hill Terrace
- E – 501 W. 184 St
- F – 521 W. 185 St
- G, H – 475, 495 W. 186 St
- I, J, K, L – 480, 485, 490, 495 W. 187 St

APPENDIX L

DEPARTMENT of ENVIRONMENTAL HEALTH and SAFETY MISCELLANEOUS FORMS

The following Hazardous Waste Pick-up Form is used only for Einstein

Hazardous Waste Pick-up Form

Environmental Health and Safety
Albert Einstein College of Medicine of Yeshiva University

DEPARTMENT of ENVIRONMENTAL HEALTH and SAFETY
Albert Einstein College of Medicine of Yeshiva University

Phone: X4150 http://www.einstein.yu.edu/ehs FAX: X8740

Requester:	Date:
Principal Investigator:	Extension:
Location of Waste:	Email:

Waste Description If mixed, list all known chemicals and concentrations	**Volume (L) or Weight (Kg)**	**# of Containers**	**Type of Container**
1.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
2.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
3.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
4.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
5.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
6.			☐ Glass ☐ Plastic ☐ Metal ☐ Box
Please note that each item of waste must have an attached Hazardous Waste label. Any container without a Hazardous Waste label cannot be picked up by Environmental Health and Safety. Improperly completed forms and labels will cause delays in waste pick-up.			

For Office Use Only

Comments:	
EH&S Technician Initial:	Date:

Upon completion: Fax to: X8740 or Mail to: EH&S - Forch 800 or Deliver to: Forch 800

YESHIVA UNIVERSITY and EINSTEIN

HAZARDOUS WASTE

START DATE: _____ END DATE:_____

SUPERVISOR: _____EXT: _____

CHEMICAL COMPONENTS	**AMOUNT**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

☐ **FLAMMABLE** ☐ **TOXIC** ☐ **REACTIVE** ☐ **CORROSIVE**

Please handle with care.

If you have any questions call:
EINSTEIN (718) 430-4150
YU (212) 923-0784

APPENDIX M

AECOM EH&S EVALUATION FORM for GRANT APPLICATIONS and RESEARCH INVOLVING HAZARDOUS MATERIALS

ALBERT EINSTEIN COLLEGE of MEDICINE of YESHIVA UNIVERSITY
DEPARTMENT of ENVIRONMENTAL HEALTH and SAFETY

Health and Safety Evaluation Form

For Research Involving All Hazards

Protocol Number: _____

Date: _____

Principal Investigator

Name: _____
Last First MI

Department: _____ E-Mail: _____

Building/Room: _____ Phone: _____ FAX: _____

Members of Laboratory

Please check the appropriate hazard for each employee

Name	Job Title	Bio.	Chem.	Rad.	Con. Sub.	Safety Use Only Training Dates BBP	HC	RAD
		☐	☐	☐	☐			
		☐	☐	☐	☐			
		☐	☐	☐	☐			
		☐	☐	☐	☐			
		☐	☐	☐	☐			
		☐	☐	☐	☐			

Con. Sub. = Controlled Substances

1. Title of Research Project: _____

2. Location of the Experiment: _____
Building and Room

3. Does your protocol utilize:

YES	NO	
☐	☐	**Biological Agents** – If Yes, complete **Section 1**
☐	☐	**Recombinant DNA** – If Yes, complete **Section 1 and Document of Registration**
☐	☐	**Hazardous Chemicals** - If Yes, complete **Section 2**
☐	☐	**Radioisotopes** - If Yes, complete **Section 3**
☐	☐	**Controlled Substances** - If Yes, complete **Section 2**
☐	☐	**Carcinogens** - If Yes, complete **Section 2**

If you indicated "Yes" for Any of the above hazards, please complete the corresponding section(s)

Section 1 (Biological information)

A. List of Infectious Agent(s) and/or Microbial Toxin(s)

	Biosafety Level * (1, 2, or 3)

*(refer to CDC handbook on EH&S website or on reserve in library)

B. Briefly describe the procedures, and the biohazard implications of the agent(s) listed above. Attach additional sheets if required.

C.

YES	NO	
☐	☐	Does your project involve recombinant DNA? If Yes, please fill out a **Document of Registration** form available with your Grant Application or from the EH&S website.
☐	☐	Will a biological Safety Cabinet be used? If No, Why? _____
☐	☐	Are emergency contact numbers accessible?
☐	☐	Is access to the laboratory restricted? If No, why? _____
☐	☐	Is there a biohazard sign on the laboratory door?
☐	☐	Will personal protective equipment be supplied? **(Check all that apply)** ☐ Gloves ☐ Lab coat ☐ Safety glasses ☐ Mask ☐ Other, please list _____
☐	☐	Do you autoclave or chemically disinfect all infectious material before disposal?
☐	☐	Are lab workers properly trained for this project?

D. Briefly explain emergency procedures for personal exposure to biological agents.

E.

YES	NO	
☐	☐	Does the project involve animals?
☐	☐	Will animals be exposed to biological agents? If yes, please complete **Section 4**.

F. **Complete Section 5**

Section 2 (Hazardous Chemicals, Carcinogens, Controlled Substances)

Please check all that apply

A.

☐ Alpha-Naphthylamine	☐ Asbestos
☐ 1,2-dibromo-3-chloropropane	☐ Arsenic, inorganic compound
☐ Acrylonitrile	☐ Benzene
☐ Ethylene oxide	☐ Benzidine
☐ Formaldehyde	☐ Ethyleneimine
☐ b-Naphthylamine	☐ 4-Aminodiphenyl
☐ Bis-Chloromethyl ether	☐ 3,3-dichlorobenzidine
☐ 2-Acetylaminofluorene	☐ Methyl Chloromethyl ether
☐ 4-Dimethylaminoazobenzene	☐ Picric Acid
☐ N-nitrosodimethylamine	☐ Perchloric Acid
☐ Vinyl chloride	☐ Others, please list _____

B.

YES	NO	
☐	☐	Do you have access to a fume hood? Building and room: _____
☐	☐	Will personal protective equipment be supplied? **(Check all that apply)** ☐ Gloves ☐ Lab coat ☐ Safety glasses ☐ Face Mask ☐ Other, please list _____
☐	☐	Do you know what a material safety data sheet (MSDS) is?
☐	☐	Are MSDSs available to your laboratory workers?
☐	☐	Do you collect all your chemical waste for disposal through the Department of Environmental Health and Safety? If No, please explain:

C. Briefly explain emergency procedures for personal exposure to chemical agents.

D.

YES	NO	
☐	☐	Does the project involve animals?
☐	☐	Will animals be exposed to hazardous agents? If Yes, please complete **Section 4**.

D. **Complete Section 5**

Section 3 (Radioisotopes)

A.

RADIOISOTOPES
(check all that apply)
- ☐ H^3
- ☐ C^{14}
- ☐ P^{32}
- ☐ S^{35}
- ☐ I^{125}
- ☐ Other, Please List _____

WASTE STREAMS
(check all that apply)
- ☐ Dry Waste
- ☐ Liquid Waste
- ☐ Animal carcasses
- ☐ Scintillation vials
- ☐ Sink Disposal

B.

YES	NO	
☐	☐	Are you currently licensed to use radioactive material?
☐	☐	Will this grant require an amendment to your existing license?
☐	☐	Do all employees working with radiation have current dosimeters (film badges)?
☐	☐	Are periodic wipe tests performed?
☐	☐	Will personal protective equipment be supplied? **(Check all that apply)** ☐ Gloves ☐ Lab coat ☐ Safety glasses ☐ Face mask ☐ other, please list _____
☐	☐	Which of the following will be used? **(Check all that apply)** ☐ Fume hood ☐ Biosafety cabinet ☐ Plexi glass ☐ Lead shielding ☐ other, please list _____
☐	☐	Will a thyroid scan be performed?

C. Briefly explain emergency procedures for personal contamination to radioactive material.

D.

YES	NO	
☐	☐	Does the project involve animals?
☐	☐	Will animals be exposed to radioisotopes? If yes, please complete **Section 4**.

D. **Section Complete 5**

Section 4 (Animals)

A. Please describe the animal handling and isolation procedures.

B.

YES	NO	
☐	☐	Will hazardous agents be excreted by animals?
☐	☐	Is the excreted material harmful to humans?
☐	☐	Have you provided the American Institute and EH&S with all the appropriate information?
☐	☐	Are cages properly labeled?

Section 5 (Worker Training)

Indicate all Health and Safety Training that has been attended.

Name of Employee	HC	BBP	TB	RAD

HC = Hazard Communication (initial or when procedures change)
BBP = Bloodborne Pathogen (annual)
TB = Tuberculosis (annual)
RAD = Radiation (initial)

If employees have not been to Health and Safety training, please contact EH&S for the next available session.

By signing below, I certify that I have read the following statements and agree that I, and all listed participants, will abide by those statements and all AECOM policies and procedures governing the use of all hazards in the laboratory, as outlined in this application. I will:

- Accept responsibility for maintaining a safe working environment, for training all personnel for specific lab procedures and informing them of the hazards associated with lab protocols before any work begins on the project and, at least annually thereafter, or if there are any changes in the protocol.
- Accept responsibility to attend, with staff, institutional health and safety training programs.
- Accept responsibility for all personnel who have occupational exposure to bloodborne pathogens to attend annual bloodborne pathogen training sessions conducted by EH&S.

Signature: _____ Date: _____
Principal Investigator

Office Use Only

Signature: _____ Date: _____
Environmental Health and Safety

Signature: _____ Date: _____
Animal Institute

If you have any questions filling out this form, please contact Delia Vieira-Cruz at extension 3560 or by e-mail at:
delia.vieira-cruz@einstein.yu.edu

ALBERT EINSTEIN COLLEGE of MEDICINE of YESHIVA UNIVERSITY
DEPARTMENT of ENVIRONMENTAL HEALTH and SAFETY

Document of Registration (DOR)

Registration of Recombinant DNA and Research Involving Infectious Material

Application Status: ☐ New Submission ☐ Renewal

Current DOR: _____

Date Received: _____ Date Expires: _____

Biosafety level ☐BSL 1 ☐BSL 2 ☐BSL 3

This form must be completed to register recombinant DNA research with the Institutional Biosafety Committee (IBC). This registration document is based on NIH "Guidelines for Research Involving Recombinant DNA Molecules." Please review the guidelines prior to filling out this registration form. To obtain the most recent edition of the guidelines you can visit the EH&S website at www.einstein.yu.edu/ehs or the NIH website http://oba.od.nih.gov/oba/rac/guidelines_02/NIH_Guidelines_Apr_02.htm

SECTION 1

Please Type or Print (unreadable forms will be returned)		
Principal Investigator:		
Department:		FAX:
Office Address:	Phone:	Email:
Lab room(s) where work will be performed:		Lab phone:

Please provide a brief summary of the proposed study (Attach additional sheets if necessary)

List names and position of those who may be involved in working with the agents listed in this registration (Attach additional sheets if necessary)	

This project will require obtaining, receiving, or handling, for research purposes the following:		
Human tissue, including blood or blood products, secretions, body fluids:	Yes [ ] No [ ]	
Organ or primary cell line derived directly from human tissue:	Yes [ ] No [ ]	
Toxins which are known to affect humans:	Yes [ ] No [ ]	If yes, please specify:
Toxins which are known to affect animals:	Yes [ ] No [ ]	If yes, please specify:

List of Infectious Agent(s):	Risk Group (check appropriate)
	BSL 1 [ ] BSL 2 [ ] BSL 3 [ ]
	BSL 1 [ ] BSL 2 [ ] BSL 3 [ ]
	BSL 1 [ ] BSL 2 [ ] BSL 3 [ ]
	BSL 1 [ ] BSL 2 [ ] BSL 3 [ ]

SECTION 2

☐ My project does not involve recombinant DNA

Please check all that apply
IIIA – IBC, RAC, NIH Director Approval needed before starting experiment –
☐ Deliberate transfer of a drug resistance trait to a microorganism that is not known to acquire that trait naturally, if such acquisition could compromise the use of the drug to control disease agents in humans, veterinary medicine or agriculture.
IIIB – NIH/OBA and IBC Approval needed before starting experiment -
☐ Cloning of toxin molecules with LD50 of less than 100 nanograms per kilogram body weight (such as microbial toxins – botulinum toxin, tetanus toxin, diphtheria toxin, S. dysenteriae neurotoxin).
IIIC – IBC, IRB and RAC approval needed before starting experiment -
☐ Deliberate transfer of rDNA or DNA or RNA derived from rDNA into 1 or more human research participants (human gene transfer).
IIID – IBC approval needed before starting experiment -
☐ Experiments using risk group 2, risk group 3, risk group 4, or restricted agents as host-vector systems
☐ DNA from Risk Group 2/3/4 or Restricted Agents is cloned into non-pathogenic prokaryotic or lower eukaryotic host-vector systems
☐ Experiments involving the use of infectious DNA or RNA viruses or Defective DNA or RNA Viruses in the presence of Helper Virus in Tissue Culture Systems
☐ Experiments involving whole animals – the animal's genome has been altered by stable introduction of recombinant DNA into transgenic animals and experiments involving viable recombinant DNA-modified microorganisms tested on whole animals.
☐ Experiments involving > 10L of culture
IIIE – IBC Notification sent at time of experiment initiation -
☐ Experiments involving the formation of rDNA molecules containing no more than 2/3 of genome of any eukaryotic virus
☐ Experiments involving the generation of rodents in which the animal's genome has been altered by stable introduction of recombinant DNA into the germ line (transgenic rodents).
IIIF – Exempt -
☐ Purchase or transfer of transgenic animals.
Exempt -
☐ Experiment not listed above

Biosafety Cabinet (BSC)		
Work performed at BSL 2 or above requires the use of a Biosafety Cabinet. The Biosafety Cabinet requires annual certification.		
Will this work be performed in a BSC?	Yes [ ] No [ ]	**Location:**
Has the BSC been certified?	Yes [ ] No [ ]	

SECTION 3

DNA INSERT (S):	
Specify source and nature of the DNA sequence(s) to be inserted (genus, species, gene name, abbreviation and function of the gene):	
Will the inserted gene(s) be expressed?	Yes [ ] No [ ]
If yes, what is the biological activity of the gene product or sequence inserted? (Specifically, any toxicity, increase virulence, oncogenic potential or ability to alter cell cycle).	

VECTOR (S):		
Describe the virus, phage and/or plasmid used for constructing recombinants:		
Identify host cell(s) or packaging cell line in which recombinant vector will be amplified:		
Is the vector replication competent?	Yes [ ] No [ ]	
Are any viral component(s)/sequence(s) present? If yes, specify the nature of the viral component (s):	Yes [ ] No [ ]	
Does the insert contain >2/3 of viral genome?	Yes [ ] No [ ]	
Is helper virus used?	Yes [ ] No [ ]	If yes, specify:

HOST (S):		
Indicate cell line (s) and species: (If E. coli, please provide strain)		
Are viral sequences present in the host that could recombine with the vector and lead to replication competent constructs?	Yes [ ] No [ ]	If yes, specify:
Does the project involve the use of transgenic animals?	Yes [ ] No [ ]	
Will animal(s) be exposed to rDNA or infectious agents?	Yes [ ] No [ ]	If yes, specify:
Can the infected animal(s) release this microorganism into the environment (excreted into bedding etc)?	Yes [ ] No [ ]	
Will transgenic animals be purchased or transferred as part of this research?	Yes [ ] No [ ]	
Has the Institutional Animal Care and Use Committee been notified?	Yes [ ] No [ ]	

SECTION 4

Please answer each question:		
* Will this research render a vaccine ineffective?	Yes [ ] No [ ]	
* Will this research involve the deliberate transfer of a drug resistance trait to microorganisms, other than antibiotic resistance genes used for cloning bacteria?	Yes [ ] No [ ]	
* Will this research enhance the virulence of a pathogen or render a non-pathogen virulent?	Yes [ ] No [ ]	
* Will this research involve the cloning of toxin molecules with LD50 < 100 ng/kg of body weight.	Yes [ ] No [ ]	
Will this research enable the weaponization or a biological agent or toxin?	Yes [ ] No [ ]	
Will this research produce any other hazards not listed above?	Yes [ ] No [ ]	If yes, specify:

- See section 2 and check appropriate box(es)

By signing below, I certify that I have provided accurate information regarding my research project and that I have read the following statements and agree that I and all listed participants will abide by those statements and all AECOM policies and procedures governing the use of recombinant DNA, infectious agents and other biological materials, as outlined in this application. I will:

- Accept responsibility for maintaining a safe working environment, for training all personnel and informing them of the hazards associated with this protocol before any work begins on this project and at least annually thereafter. In addition, all personnel who have occupational exposure to bloodborne pathogens will attend annual bloodborne pathogen training sessions conducted by EH&S.
- Submit in writing a request for approval from the Institutional Biosafety Committee (IBC) of any significant modifications to the study, facilities, or procedures.
- Whenever possible, if exposure to infectious agents or toxins will occur, banking of serum or appropriate skin testing for pre-exposure data should be obtained, cataloged, and stored. If a vaccine is available, laboratory members should be offered vaccine prophylaxis or appropriate documentation of refusal should be obtained.

Signature of Principal Investigator: _____ Date: _____

Return Original Document of Registration (DOR), to: Delia Vieira-Cruz, Laboratory Safety Officer - Forchheimer 800 X3560