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# GN470094 - HANDLING CHEMICALS AT SNL/CA

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Subject Matter Expert: [Donn Wright](#)

GN470094, Issue C

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\* Indicates a substantive change

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**Note:** Many of the attachments consist of tables of chemicals that are known or thought to present a variety of hazards. These lists must be used with caution, because in general, exposure quantities or paths that produce the effects indicated are not listed in the tables. The original reference for tables should be consulted for more complete information when evaluating risks presented by particular laboratory operations. These lists are intended to serve only as a preliminary source of information for evaluating laboratory risks.

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## 1.0 PURPOSE, SCOPE, AND OWNERSHIP

### 1.1 Purpose

This supplement governs the acquisition, storage, use, and disposal of hazardous chemicals for both the OSHA Hazard Communication Standard and the Laboratory Standard at SNL/CA. The intention of this document is to ensure that routine chemical operations at SNL/CA are conducted in such a way as to minimize the risk to Members of the Workforce, threat to the environment, and the generation of hazardous waste. This document supplements CPR400.1.1/MN471001, *ES&H Manual*, [Section 6E](#), "Laboratory Standard - Chemical Hygiene Plan."

This document governs the use of hazardous chemicals. This document does not govern the use of the following:

- Explosives
- Lasers
- High-pressure gases
- Toxic or corrosive gases
- Radioactive materials

It is the joint responsibility of department managers and owners of chemical work areas to determine whether any specific operation requires an activity-specific ES&H technical work document (TWD). Call the ES&H Hotline at 294-3724 if you need assistance.

### 1.2 Applicability

For purposes of this document, Members of the Workforce are:

- Sandia [employees](#).
- Sandia contractors as specified in [Section 1B](#), "What Is the Scope."

This section applies to all Members of the Workforce who handle chemicals at SNL/CA.

### 1.3 Ownership

The Health and Safety Department (8517) is responsible for this document. Send suggested changes to Donn Wright, MS 9221.



## 2.0 RESPONSIBILITIES

### 2.1 General

The safe handling of hazardous chemicals is an **individual** responsibility. Management responsibility lies with department managers and with delegated individuals for a particular operation. All personnel must understand that chemical safety is an integral part of the job and not an optional function. There is no activity that is so urgent that it is necessary to compromise safety or to endanger the environment.

During any operation, anyone may question the safety of any aspect of an activity and may at any time request and be granted the immediate cessation of the activity. Such requests should be made to the department manager or person conducting the operation at that time. The department manager has the authority to make an initial evaluation and decision to stop or to continue the operation. However, the individual questioning the safety of the operation should contact their center director if the question is not resolved satisfactorily. If the operation is immediately dangerous to life or health, the individual questioning the safety of the operation is authorized to immediately terminate the operation in a manner that eliminates or reduces the hazard and does not introduce new hazards that are immediately dangerous to life or health.

### 2.2 Center Directors

Center directors have the ultimate responsibility and authority to ensure that all experimental and support activities within a center are conducted in compliance with [MN471001](#), *ES&H Manual*, with applicable federal and state laws and regulations, with this supplement, and with the specific ES&H technical work documents (TWDs) written for each experiment or hazardous operation.

Center directors have other specific responsibilities as indicated in [MN471001](#), *ES&H Manual*, and [PN471001](#), *Corporate Chemical Hygiene Plan*.

### 2.3 Department Managers

Department managers shall perform these tasks:

- Ensure the safe performance of experimental and support activities.
- Critically examine health and safety aspects of all chemical operations within their departments and other departments that interface with chemical operations.
- Determine whether a particular operation needs an activity-specific ES&H TWD.
- Follow requirements in [MN471001](#), *ES&H Manual*.
- Adhere to Laboratory Standard requirements, if applicable, listed in [PN471001](#), *Corporate Chemical Hygiene Plan*.
- Perform an annual physical verification of the inventory and records of sensitive chemicals.



## 2.4 Individual Laboratory Owners and Workers

Each individual laboratory owner or worker (including non-permanent employees and contractors) is responsible for the following tasks:

- Take all reasonable precautions to avoid endangering the environment and to prevent personal injury and injury to associates.
- Be familiar with hazards associated with particular chemicals with which he/she is working.
- Know how to obtain a copy of the chemical inventory and MSDSs for all chemicals.
- Understand and follow approved safety and operational procedures.
- Know which OSHA regulation (Hazard Communication Standard or Laboratory Standard) applies to chemical handling operations.
- Take training as deemed appropriate by their department manager.
- Obtain special permits, if applicable, for operations that result in emissions to the atmosphere, and check with Air Quality in the Environmental Operations Department (8516) for assistance.
- Dispose of waste generated during work according to procedures in [GN470075](#), *Guidelines for Hazardous Waste Generators at SNL/CA*.
- Check with their department manager if uncertain about any phase of operations.

Laboratory owners and personnel who perform work in a laboratory that is designated as an OSHA Laboratory Standard location have other specific responsibilities as indicated in PN471001, *Corporate Chemical Hygiene Plan*.

## 2.5 Deputy Chemical Hygiene Officers (DCHOs)

Deputy chemical hygiene officers (DCHOs) assigned responsibility for the designated OSHA Laboratory Standard locations have specific responsibilities as indicated in [PN471001](#), *Corporate Chemical Hygiene Plan*.

## 2.6 Visitors

### 2.6.1 Casual Visitors

All casual visitors who enter chemical work areas shall be familiar with the types of chemical hazards and any special precautions for the area.

### 2.6.2 Non-Casual Visitors

Non-casual visitors must meet site-specific training requirements for the Hazard Communication Standard or Laboratory Standard.

## 3.0 DEFINITIONS

**Action level** - The chemical specific exposure level (concentration of material in air) which is generally considered to be one half the TLV or PEL. When the action level is reached, measures are taken to reduce exposures. Such measures may include the use of engineering or administrative controls. Requirements for medical surveillance may also apply.

**Acutely toxic** - A substance that has been found to have adverse effects resulting from a single dose or a short-duration exposure.

**Carcinogen/select carcinogen** - Any substance which meets one of the following criteria:

- Regulated by OSHA as a carcinogen.
- Listed under the category, "known to be carcinogens," in the latest edition of the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP).
- Listed under the latest edition of Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC).
- Listed in either Group 2A or 2B by the IARC or under the category "reasonably anticipated to be carcinogens" by the NTP, and which causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
  - After inhalation exposure to dosages of less than 10 mg/m<sup>3</sup> for 6 to 7 hours per day, 5 days per week, for a significant portion of a lifetime.
  - After repeated skin application of less than 300 mg/kg of body weight per week.
  - After oral dosages of less than 50 mg/kg of body weight per day.
- Listed as an ACGIH A1- or A2-designated carcinogen.

**Casual visitors** - A casual visitor is one who comes to chemical work areas for a short time duration. The casual visitor may be present for a briefing or a tour, to observe a specific experiment, to consult with a staff member, to collect chemical waste, to perform maintenance or janitorial duties, etc. Casual visitors do not actively engage in experiments or other chemical operations.

**Chemical work area** - A workplace where chemicals are used.

**Chlorofluorocarbons (CFCs)** - These are perhalogenated compounds (also called Freons) that are non-toxic and chemically quite stable. They persist in the atmosphere for years until they reach high elevations, where they photochemically decompose. Their decomposition products are believed to be responsible for catalytic destruction of the protective ozone layer.

**Chronically toxic** - A substance that has been found to have adverse effects which become evident after repeated doses, long-duration exposure, or a long latency period.

**Combustible liquid** - Any liquid having a flash point at or above 100°F (37.8°C), but below 200°F (93.3°C). Also any mixture having components with flash points of 200°F (93.3°C) or higher, the total volumes of which make up 99% or more of the total volume of the mixture.

**Compressed gas** - A gas that falls into one of the following categories:



- A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C).
- 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).
- A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C).

**Corrosive** - A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. This term does not refer to action on inanimate surfaces.

**Designated area** - (Applies to OSHA Laboratory Standard locations.) An area that may be used for work with particularly hazardous substances. A designated area may be the entire laboratory or a device such as a laboratory hood.

**Environmental hazard** - Materials that are of environmental concern. Examples are volatile organic compounds (VOCs), chlorofluorocarbons (CFCs), and greenhouse gases.

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

**Flammable** - A chemical that falls into one of the following categories:

- Flammable aerosol
- Flammable gas
- Flammable liquid
- Flammable solid

**Flammable aerosol** - An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.

**Flammable gas** - 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 wider than 12% by volume, regardless of the lower limit.

**Flammable liquid** - A liquid that can be readily ignited at room temperature. Defined by the National Fire Protection Association (NFPA) and the Department of Transportation (DOT) as a liquid with a flash point below 100°F (38°C).

**Flammable solid** - A solid, other than a blasting agent or explosive, 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.

**Flash point** - The minimum temperature at which a liquid gives off sufficient vapor to first form an ignitable mixture with the air near the surface of the liquid or within a test vessel.

**Greenhouse gases** - Gases that persist in the atmosphere and are implicated in long-term warming of the earth. They are transparent to ultraviolet radiation from the sun, but reflect infrared radiation that is emitted from the earth.

**Hazardous chemical** - A chemical for which there is statistically significant evidence based on at least one study

conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are:

- Carcinogens.
- Toxic or highly toxic agents.
- Reproductive toxins.
- Irritants.
- Corrosives.
- Sensitizers.
- Hepatotoxins.
- Nephrotoxins.
- Neurotoxins.
- Agents which act on the hematopoietic systems.
- Agents which damage the lungs, skin, eyes, or mucous membranes.

**Hazardous waste** - Hazardous waste at SNL/CA is any waste that is chemical in nature and either meets the definition of ignitability, corrosivity, reactivity, or toxicity; or is specifically listed in Title 22 of the California Code of Regulations (see GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*). Most chemicals are required to be managed as hazardous waste when discarded at SNL/CA.

**Health hazard** - See the definition for "[Hazardous Chemical](#)."

**IDLH** - Immediately dangerous to life and health. The maximum concentration of an airborne chemical from which an individual could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.

**Irritant** - A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact as a function of concentration or duration of exposure. A substance that produces an irritating effect when in contact with skin, eyes, nose, or respiratory systems.

**Laboratory** - (Applies to OSHA Laboratory Standard locations.) 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** - 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 use of hazardous chemicals** - (Applies to OSHA Laboratory Standard locations.) Handling or use of such chemicals in which all of the following criteria are met:

- Chemical manipulations are carried out on a "laboratory scale."

- Multiple chemical procedures or chemicals are used.
- The procedures involved are not part of a production process, nor in any way simulate a production process.
- "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

**LC<sub>50</sub>** - Lethal concentration 50. Lethal concentration in air that will kill 50% of an exposed animal population within a specified time.

**LD<sub>50</sub>** - Lethal dose 50. The dose of a substance that causes the death of 50% of an exposed animal population within a specified time from a single-dose exposure to the substance by any route other than inhalation.

**MSDS** - Material safety data sheet. The form used to inform an employee about the hazards of the materials he/she works with so that he/she knows how the material can be safely handled, used, and stored. OSHA has established guidelines for the descriptive information that should be provided on an MSDS.

**Must** - Used to designate mandatory actions that are required by center policy and procedures.

**Non-casual visitor** - Anyone who is not normally assigned to an area, but performs hands-on chemical work.

**Organic peroxide** - An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical. As a class, these compounds may be low-power explosives, and are hazardous because of their extreme sensitivity to shock, sparks, or other forms of accidental ignition. All organic peroxides are highly flammable.

**OSHA** - Occupational Safety and Health Administration. The regulatory and enforcement agency for safety and health in most U.S. industrial sectors.

**Oxidizer** - A chemical other than a blasting agent or explosive that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

**Particularly hazardous substance** - (Applies to OSHA Laboratory Standard locations.) Select carcinogens, reproductive toxins, and substances which have a high degree of acute toxicity.

**PEL** - Permissible exposure limit. A PEL is the OSHA equivalent to the TLV. See the definitions for "[TLV](#)." A PEL is usually expressed as an 8-hour time-weighted average. Ceiling limits may be specified for some chemicals. This concentration, if specified, **cannot** be exceeded for any part of the work shift. DOE orders mandate adherence to ACGIH TLVs and OSHA PELs, whichever limit is lower.

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

**Pyrophoric** - A chemical that will ignite spontaneously emitting sparks when scratched or struck in air at a temperature of 130°F (54.4°C) or below.

**Reproductive toxins** - Chemicals which may present reproductive risk to females or males (mutagens), or developmental risk to the fetus (teratogens). These agents may act on various aspects of the reproductive cycle, from sperm and egg production to latent cancer in offspring.



**Secondary chemical container** - Any container other than a primary (original) container supplied by a manufacturer.

**Sensitive chemicals** - Chemicals that can be used as precursors in the synthesis of controlled substances are subject to regulation. These are listed in [Attachment A](#).

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




**Shall** - Used to designate mandatory requirements or actions. Indicates actions traceable to laws, regulations, DOE orders, or [MN471001](#), *ES&H Manual*.

**Should** - Used to designate "best practices" and means that the action described is recommended but not required by law.

**Target organ effects** - Table 1 is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. Examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, but are not intended to be all-inclusive.

**Table 1. Summary of Target Organ Effects**

Category	Description	Signs and Symptoms	Chemicals
Hepatotoxins	Chemicals which produce liver damage	<ul style="list-style-type: none"> <li>• Jaundice</li> <li>• Liver enlargement</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon tetrachloride</li> <li>• Nitrosamines</li> </ul>
Nephrotoxins	Chemicals which produce kidney damage	<ul style="list-style-type: none"> <li>• Edema</li> <li>• Proteinuria</li> </ul>	<ul style="list-style-type: none"> <li>• Halogenated hydrocarbons</li> <li>• Uranium</li> </ul>
Neurotoxins	Chemicals which produce their primary toxic effects on the nervous system	<ul style="list-style-type: none"> <li>• Narcosis</li> <li>• Behavioral changes</li> <li>• Decrease in motor functions</li> </ul>	<ul style="list-style-type: none"> <li>• Mercury</li> <li>• Carbon disulfide</li> <li>• Lead</li> <li>• Solvents as a general class</li> </ul>
Agents which act on the blood or hematopoietic system	Chemicals which decrease hemoglobin function, deprive the body tissues of oxygen	<ul style="list-style-type: none"> <li>• Cyanosis</li> <li>• Loss of consciousness</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon monoxide</li> <li>• Cyanides</li> <li>• Benzene</li> </ul>

Agents which damage the lung 	Chemicals which irritate or damage the pulmonary tissue	<ul style="list-style-type: none"> <li>• Cough</li> <li>• Tightness in chest</li> <li>• Shortness of breath</li> </ul>	<ul style="list-style-type: none"> <li>• Sulfur dioxide</li> <li>• Ozone</li> <li>• Bromine</li> <li>• Formaldehyde</li> <li>• Hydrogen sulfide</li> <li>• Nitrogen dioxide</li> </ul>
Reproductive toxins 	Chemicals which affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis)	<ul style="list-style-type: none"> <li>• Birth defects</li> <li>• Sterility</li> </ul>	<ul style="list-style-type: none"> <li>• Lead</li> <li>• DBCP</li> <li>• Ethanol</li> </ul>
Cutaneous hazards	Chemicals which affect the dermal layer of the body	<ul style="list-style-type: none"> <li>• Defatting of the skin</li> <li>• Rashes</li> <li>• Irritation</li> </ul>	<ul style="list-style-type: none"> <li>• Ketones</li> <li>• Chlorinated compounds</li> </ul>
Eye hazards 	Chemicals which affect the eye or visual capacity	<ul style="list-style-type: none"> <li>• Conjunctivitis</li> <li>• Corneal damage</li> </ul>	<ul style="list-style-type: none"> <li>• Organic solvents</li> <li>• Acids</li> </ul>

**TLV** - Threshold limit value. See definition for "[TLV-TWA](#)."

**TLV--ceiling** - Threshold limit value--ceiling. The maximum airborne concentration which should not be exceeded during any part of a work day.

**TLV--STEL** - Threshold limit value--short-term exposure limit. The 15-minute TWA which should not be exceeded at any time during a work day.

**TLV--TWA** - Threshold limit value--time-weighted average. Average (usually over an 8-hour period) airborne concentration to which nearly all workers may be repeatedly exposed day after day without adverse effects. This term is usually referred to as "threshold limit value (TLV)." DOE orders mandate adherence to ACGIH TLVs and OSHA PELs, whichever limit is lower.

**Toxic** - A chemical falling within any of the following categories (see [Attachment B](#) for information on classifications):

- A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 50 mg/kg but not more than 500 mg/kg of body

weight when administered orally to albino rats weighing between 200 and 300 grams each.

- A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 200 mg/kg but not more than 1000 mg/kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
- A chemical that has a median lethal concentration (LC<sub>50</sub>) in air of more than 200 parts per million but not more than 2000 parts per million by volume of gas or vapor, or more than two mg/liter but not more than 20 mg/liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

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

**Volatile organic compounds (VOCs)** - These are gases or liquids and solids with high vapor pressure that could be released to the air. These materials are implicated in the formation of smog and elevation of near-surface ozone levels.

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

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## 4.0 TRAINING

The most effective method to ensure that hazardous chemicals are handled properly is to ensure that all personnel who handle chemicals are fully informed as to their proper use, storage, and disposal.

All personnel who are engaged in work that involves the handling of hazardous chemicals shall receive basic SNL training appropriate to their work in either a Hazard Communication Standard or a designated OSHA Laboratory Standard location. See the HAZ, LAB, and TOX series of courses in [TEDS Everyone](#), for a description of applicable training courses.

Work in an office environment which involves the "household use" of chemicals or the use of computers or printer toners for photocopiers and fax machines is governed by the Hazard Communication Standard. These personnel are only required to take the Hazard Communication Briefing, HAZ178, included in the ES&H New Employee Orientation.

Additional training may be required depending on the exact nature of the hazards in a particular operation. For example, radiation safety training may be necessary to handle radioactive materials. Department managers shall be consulted for specific training requirements for personnel assigned to chemical work areas.

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## 5.0 PROTECTIVE EQUIPMENT

### 5.1 Hazards

Chemicals present a very broad range of hazards to personnel and to the environment (if they are released). Specific chemicals that represent the full range of chemical hazards are present in many chemical work areas.

## 5.2 Personal Protective Equipment

All personnel present in chemical work areas when hazardous chemicals are in use shall use appropriate protective glasses (ANSI Z87.1A approved), goggles, and/or face shields. Adequate quantities of plastic safety glasses or goggles shall be conveniently available for visitors. If there is a potential for irritants or corrosive chemicals splashing in an operation, then splash-resistant safety goggles (i.e., with baffled vents) or face shields shall be worn.

Appropriate gloves shall be worn when handling irritants, sensitizers, toxic chemicals, particularly hazardous substances, or chemicals with unknown toxicological properties. Gloves should be available in appropriate sizes and materials for the work performed in the area. For guidance in selecting gloves, consult an industrial hygienist in the Health and Safety Department (8517).

Laboratory coats or other appropriate protective clothing shall be used as appropriate.

A respirator shall be worn if exposure to chemicals will exceed the action level. Use of respirators shall conform to requirements of the Sandia Respiratory Protection Program and PN471001, *Corporate Chemical Hygiene Plan* (applies to designated OSHA Laboratory Standard locations). To become an active user of respiratory equipment, contact the respirator program administrator in the Health and Safety Department (8517). See MN471001, *ES&H Manual*, Chapter 6, [Section C](#), "Respiratory Protection," for more information.

## 5.3 Containment Devices

Fume hoods or similar containment devices shall be used for experiments that could emit any of the following:

- Gases
- Dust
- Mists
- Vapors
- Fumes
- Vigorous chemical reaction (if practical)

Fume hoods shall be surveyed after installation and annually thereafter. Laboratory owners shall contact an industrial hygienist in the Health and Safety Department (8517) for the survey to be performed. For further information on laboratory ventilation and use of fume hoods, see MN471001, *ES&H Manual*, [Chapter 6, Section P](#), "Local Exhaust Ventilation (LEV)," and PN471001, *Corporate Chemical Hygiene Plan* (applies to designated OSHA Laboratory Standard locations).

## \*5.4 Safety Showers and Eyewashes

Every chemical work area shall be evaluated to determine if an eyewash and/or safety shower is required. The requirements for eyewashes and safety showers are listed in MN471001, *ES&H Manual*, [Section 6M](#), "Safety Showers and Eyewashes." Emergency eyewashes shall be flow tested on a weekly basis. Safety showers shall be tested monthly. Flow testing shall be documented, and documentation maintained for a minimum of 365 days.

## 5.5 Fire Extinguishers and Telephones

Laboratories shall have access to appropriate fire extinguishers.

Every chemical work area shall be equipped with a telephone for emergency use. The telephone shall include a sticker with the emergency number and room location.

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## 6.0 PROCUREMENT OF CHEMICALS

### 6.1 General Guidelines

Before procuring any chemical, laboratory workers shall become familiar with the hazards associated with that material by consulting any of the following:

- Current references for hazardous materials
- MSDS
- Vendor
- Health and Safety Department (8517)

If a chemical is hazardous (or sensitive), laboratory workers shall:

- Use a less hazardous chemical as an alternative, if possible.
- Use the chemical only in a suitable facility (e.g., perchloric acid use may require specially designed fume hoods with wash-down capabilities).
- Ensure that appropriate storage facilities are available.

When procuring chemicals, personnel should avoid ordering excess quantities. For hazardous materials, personnel should not feel constrained to order "catalog" quantities. Many chemical suppliers will supply specific amounts of such items. There will be a price premium, but that is preferable to the price for disposal of excess quantities. Chemical quantities on hand should be limited to the volumes necessary for one supply cycle. Personnel should check the [Chemical Information System \(CIS\)](#) to see if the chemical can be obtained from other onsite locations.

Purchase requisitions for chemicals must be approved by an industrial hygienist in the Health and Safety Department (8517). Most chemicals arrive through the Logistics and Procurement Department (8523) and are barcoded and inventoried before delivery to individual chemical work areas.

No chemical should be accepted from a supplier if it is incorrectly labeled. The manufacturer's or importer's label must contain the following information:

- Chemical name
- Name and address of chemical manufacturer, importer, or other responsible party
- Any physical or chemical hazards associated with the chemical

Personnel must be able to obtain the MSDS and inventory either by accessing the [Chemical Information System \(CIS\)](#), Sandia's Internal Web at <http://cis.sandia.gov>, or by contacting the ES&H Hotline at 294-3724.

## 6.2 Flammable Liquids

Flammable liquids shall be procured in containers of sizes that conform to both OSHA regulations and National Fire Protection Association (NFPA) codes (see Attachments [C](#), [D](#), [E](#), and [F](#)).

## 6.3 Sensitive Chemicals

Sensitive chemicals (see [Attachment A](#)) shall be procured according to the following:

- Ordered by the specific name.
- Identified on the purchase requisition as "controlled."
- Approved via necessary special approvals.

In addition, personnel ordering such chemicals shall ensure that any other legal restrictions associated with the use of a particular material are obeyed.

## 6.4 Explosive Chemicals

Procurement of explosive chemicals is not covered in this document. However, certain chemicals are explosive, but may not be identified as such (see [Attachment G](#)). These materials shall be procured and handled as explosives and their use requires an activity-specific ES&H TWD.

Upon receipt of any explosive chemical, personnel shall ensure that the:

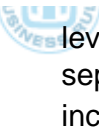
- Chemical is labeled correctly.
- MSDS is available.
- Chemical is stored correctly.
- Chemical is added to the [Chemical Information System \(CIS\)](#).
- Chemical is added to the ongoing chemical inventory for the chemical work area.

# \*7.0 STORAGE OF CHEMICALS

## 7.1 General Guidelines

All chemicals shall be stored:

- To minimize risk to personnel and the environment.
- Outside of a fume hood. Fume hoods are not chemical storage areas.
- To avoid common storage of incompatible materials. Incompatible materials shall be stored separately, with the




level of separation based on the severity of the incompatibility (e.g., acids and bases may be placed in separate secondary chemical containers on separate shelves). See [Attachment H](#) for a listing of storage incompatibilities.

- Away from exposure to direct sunlight.
- In closed containers that are in good condition.
- If flammable and requiring refrigeration, in an explosion-proof refrigerator.

A chemical storage shed should:

- Be an unmanned, special facility if possible.
- Be placed in a location approved by the fire marshal in the Health and Safety Department (8517) and must meet fire protection engineering specifications.
- Be clearly labeled to identify the particular hazards associated with the chemicals stored in the facility.
- Have appropriate temperature control systems, ventilation systems, and fire control systems.
- Contain storage cabinets that prevent chemicals from tipping over in an earthquake. Chemicals should not be stored on open shelves in such a way that they might fall off during an earthquake. Seismic restraints should be placed at 2/3 the height of the chemical container.

Stored chemicals should be examined at least annually for signs of deterioration or degradation of container integrity. Some chemicals are subject to degradation with time (see Attachment I [\[Word file/Acrobat file\]](#)) and storage of these materials shall be regularly reviewed.



All liquid chemicals in quantities greater than one pint shall be placed in a spill tray when they are not in use. Solid chemicals do not require secondary containment. Chemicals requiring secondary containment may be stored in manufactured and approved chemical storage cabinets; additional tubs, trays, etc. are not required.

Secondary chemical containers must be labeled with the chemical name and appropriate hazard warning information. For more information, see MN471001, *ES&H Manual*, Chapter 6, [Section D](#), "Hazard Communication."

## 7.2 Carcinogens and Select Carcinogens

Carcinogens and select carcinogens (see Attachments [J](#), [K](#) [\[Word file/Acrobat file\]](#), and [L](#) [\[Word file/Acrobat file\]](#)) shall be stored in a designated area, such as a chemical storage shed, cabinet, or refrigerator. The storage area shall be:

- Appropriate for other hazardous properties of such materials.
- Clearly labeled as containing carcinogens.
- Continuously ventilated if there is a possibility that vapors from carcinogens could accumulate.

## 7.3 Flammable Chemicals

Flammable chemicals shall be stored in a flammable storage cabinet. Contact the fire marshal in the Health and Safety Department (8517) for guidance in the placement of flammable storage cabinets. Such cabinets are normally

not vented, and vent bungs should be in place (where accumulating vapors pose problems, an industrial hygienist and the fire marshal in the Health and Safety Department [8517] should be consulted).

Flammable solids (in amounts greater than two ounces) should be stored in a flammable storage cabinet that has been labeled "Flammable Solids."

## 7.4 Sensitive Chemicals

Sensitive chemicals shall be stored in a separate, locked storage cabinet. Labels should indicate the specific hazards of the contents and that the contents are "controlled."

## \*7.5 Peroxidizable Chemicals

[D-DOE 440.1A, S]

**Note:** The provisions within this section contain strict requirements regarding the use of peroxidizable chemicals due to the high potential for adverse effects from inappropriate use and/or storage thereof. However, in certain applications, researchers may wish to operate beyond these requirements. In these situations, researchers shall submit to ES&H for review, a new technical work document (TWD) or revise a current TWD through an Interim Change Notice, or submit an SWP that includes procedures and controls that will be followed to ensure the safety of personnel expected to use peroxidizable chemicals beyond the scope of this document.

Under the appropriate conditions, a number of organic and inorganic chemical compounds used at SNL are capable of reacting with atmospheric oxygen to form peroxide compounds. Many of these peroxides are highly flammable and may explode if exposed to heat, mechanical shock, friction or light. Potential adverse health effects may result if one is exposed to these peroxides should a container rupture. Three lists of common peroxide-forming chemicals grouped by hazard mechanism are found in tables 2, 3, and 4. The SNL chemical inventory can be queried for these listed chemicals using the three CIS queries: Peroxidizable Substances, Peroxidizable Substances (Concentrated), and [Autopolymerizable Substances Reports](#). While these are the most commonly encountered peroxide-forming chemicals, these lists **are not** all inclusive and do not contain all potential peroxide-forming compounds. Consequently, chemical users shall always consult individual MSDSs to ensure they are aware all chemical hazards. Peroxide-forming chemicals have different inherent potentials for forming peroxides, as designated by chemical groups, and therefore some are potentially more hazardous than others. Users can contact Industrial Hygiene for guidance regarding the relative potential for peroxide formation.

## Requirements

Chemical owners and users shall be responsible for the safe use and storage of any chemical and especially peroxide-forming chemicals.

Chemical owners and users shall implement one or more of the following controls to minimize the formation of peroxides and to effect proper handling and storage:

- Purchase only chemicals that contain an oxidation inhibitor whenever possible.
- Limit quantities to the minimum amount that will be needed within the expiration period of the chemical. A better price for a larger quantity should never be considered.
- Review the Material Safety Data Sheet for the chemical to determine proper handling and storage conditions for the material.
- Store in approved location (e.g., chemical storage shed) in the original container whenever possible and ensure



the lid is always air-tight.

- Store away from heat and light.
- Ensure that the ventilation system is maintained for chemical storage sheds by visiting sheds frequently (e.g., monthly).
- Label all containers with the date the material was received, the date the container was opened and the disposal date. If tested for peroxide buildup, include such information on the label. Call the ES&H Hotline, 4-ESAH, to obtain standard labels.
- For those chemicals that form peroxides on concentration, Table 3, mark and date the liquid level on the bottle, if possible, after each use. This will allow personnel to note whether there has been leakage from the bottle during storage. Leakage may lead to build-up of peroxide forming compounds.
- Use or dispose of the containers by the expiration date. If an expressed interest exists to retain the chemical beyond the retention date, a measurement of peroxide levels using an oxidizer test strip shall be taken. Containers that have been tested for peroxide levels shall be labeled to indicate the test date and results. Chemical owners/users shall be responsible for conducting the testing of peroxide levels.
- Containers of peroxide chemicals shall be retested at frequencies sufficient to assure that the peroxide levels will not exceed 30 ppm during continued storage.
- Peroxide levels of 30 ppm or greater require the chemical to be disposed through Hazardous & Radioactive Waste at 294-2145.

Chemical owners and users having containers of peroxide-forming chemicals shall:

- Dispose of them **at or before their expiration date** through Hazardous Waste Management.
- Complete a Hazardous Waste tag (see [Figure 1](#)) when it is determined that it is necessary to dispose of the material.
- Contact Hazardous & Radioactive Waste in a timely manner.

**Note:** Safe retention dates for chemicals are:

- Opened containers in Table 2 - 3 months.
- Opened containers in Table 3 - 12 months.
- Opened containers in Table 4 without inhibitor - 24 hours.
- Opened containers in Table 4 with inhibitor - 12 months.
- No container may be kept beyond **2 years** of purchase even with monitoring of peroxide levels.

Chemical owners and users shall treat containers of peroxidizable chemicals that meet one or more of the criteria listed below as potentially explosive:

- Two years beyond purchase date.
- Of unknown history.

- Show visible discoloration, crystallization or liquid stratification.
- Show visible rust, (e.g., older steel containers).

Members of the Workforce shall:

- **Not** move or open any container that meets one or more of the above conditions.
- Take appropriate actions to isolate or secure access to such containers.
- Contact the ES&H Hotline (4-ESAH) to arrange for an inspection and disposal of the container.

**Table 2. Chemicals that can form explosive levels of peroxides without concentration.**

Container disposal date is **3 months** from **open date**.

Butadiene <sup>a</sup>	Chloroprene <sup>b</sup>
Divinyl acetylene	Isopropyl ether
Potassium amide	Potassium metal
Sodium amide	Tetrafluoroethylene <sup>a</sup>
Vinylidene chloride <sup>a</sup>	
<sup>a</sup> When stored as an <b>inhibited</b> liquid monomer (see Table 3 for additional concerns). <sup>b</sup> When stored as a liquid monomer.	

**Table 3. Chemicals that can form explosive levels of peroxides when concentrated (such as by evaporation or distillation).**

Container disposal date is **12 months** from **open date**.

Acetal	Acetaldehyde
Benzyl alcohol	2-Butanol
Chlorofluoroethylene <sup>l</sup>	Cumene (isopropylbenzene)
2-Cyclohexen-1-ol	Cyclohexene
Cyclopentene	Decahydronaphthalene (decalin)
Diacetylene (butadiyne)	Dicyclopentadiene
Diethyl ether	Diethylene glycol dimethyl ether (diglyme)
Dioxanes	Ethylene glycol ether acetates (cellosolves)
Furan	4-Heptanol
2-Hexanol	Methyl acetylene
3-Methyl-1-butanol	4-Methyl-2-pentanol
Methyl-isobutyl ketone	2-Pentanol
4-Pentene-1-ol	1-Phenylethanol
2-Phenylethanol	Tetrahydrofuran

Tetrahydronaphthalene	Vinyl ethers
Other secondary alcohols <sup>c</sup>	

<sup>c</sup> Where potentially peroxidizable alcohols are used for purposes that **DO NOT** involve heating, chemical reaction, bulk evaporation or other activities that may stress the peroxidizable material, (e.g., cleaning optics, laser dye mixing), it is not necessary to track and test the containers for peroxidation.

**Table 4. Chemicals that may autopolymerize (and thus explode) when relatively small quantities of peroxides are formed.**

Container disposal date is **24 hours without inhibitor** from **open date**.

Container disposal date is **12 months with inhibitor** from **open date**.

Butadiene (stored as a gas) <sup>d</sup>	Chlorobutadiene
Chloroprene <sup>d</sup>	Chlorotrifluoroethylen
Styrene	Tetrafluoroethylene <sup>d</sup>
Vinylidene chloride <sup>d</sup>	Vinyl acetate
Vinyl acetylene	Vinyl chloride
Vinyl pyridine	

<sup>d</sup> Can form explosive levels of peroxides when stored as liquid **without inhibitor**. When stored as gas, peroxide accumulation may cause autopolymerization.

**Figure 1. Example Peroxide Chemical Label**

Peroxide Chemical Label Peroxidizable Compound May Become Explosive with Time or Exposure to Air or Light		
Date Received: _____		
Date Opened: _____		
Test Date	PPM Results	Initial
_____	_____	_____
_____	_____	_____
Discard Chemical if Results are 30 ppm		
Disposal Date: _____		

## 8.0 USE OF CHEMICALS

### 8.1 General Procedures

Personnel shall follow these general procedures for their personal safety and protection of the environment:

- Personnel should avoid underestimation of risk.
- Exposure should be minimized, even for substances of no known significant hazard. Personnel should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.
- Exposure to any chemical should be minimized because few laboratory chemicals are without hazards. Skin contact with chemicals should be avoided.
- Personnel should avoid working alone with hazardous materials or performing hazardous operations in a locked laboratory or after normal working hours.
- No one should intentionally taste or smell chemicals.
- Mouth suction for pipetting shall not be used.
- Chemical operations should be conducted in such a way as to minimize generation of hazardous waste.
- Chemicals shall be disposed of properly. Chemicals shall never be poured into sinks or allowed to evaporate as a means of disposal.
- Personnel should properly dispose of experimental samples unless required for archival purposes.
- Upon transfer or leaving Sandia employment, laboratory workers shall arrange for the disposal or transfer of all chemicals for which they are responsible.
- Secondary containment is not required for chemicals in use. All chemicals shall be placed in storage overnight.
- There shall be no eating, drinking, chewing gum, smoking, or application of cosmetics in chemical work or storage areas.

In addition, personnel shall follow these general procedures:

- Shoes that expose toes, or any portion of the foot, shall not be worn in chemical work or storage areas.
- When possible, contact lenses should not be worn in a chemical work area, but replaced by safety glasses. If this is not possible, unvented goggles should be used to cover the contact lenses and eyes.
- Chemicals shall **not** be stored in fume hoods.
- Personnel shall coordinate, as practical, with other laboratory workers to share infrequently used chemicals, designating one laboratory for storage for a particular chemical.
- Personnel should know how to get MSDSs and a copy of the chemical inventory from the [Chemical Information System](#). Personnel should contact the ES&H Hotline at 294-3724 for assistance.

## 8.2 Facilities

Chemical work areas shall be maintained separately from office areas. Wherever possible, such locations should have two exits. For further clarification of this requirement, contact the fire marshal in the Health and Safety Department (8517).

Every chemical work area shall have the appropriate Sandia Workplace Hazard Awareness System (SWHAS) sign on every entrance to identify specific hazards of materials contained therein. The names of responsible individuals shall be listed there.



## 8.3 Emissions Control

All personnel shall conduct operations in a manner that minimizes the emission of all chemicals. Emissions are regulated locally by the Bay Area Air Quality Management District (BAAQMD). If operations that produce or may produce chemical emissions are underway or are being planned, personnel shall contact the Environmental Operations Department (8516) to determine if permits are required. If a permit is required, operations shall not proceed until appropriate emissions logging procedures and reporting procedures are in place.

## 8.4 Particularly Hazardous Substances (Applies to OSHA Laboratory Standard Locations)

Particularly hazardous substances (see Attachments [J](#), [K](#) [[Word file/Acrobat file](#)], [L](#) [[Word file/Acrobat file](#)], [M](#), [N](#) and [O](#)) shall be handled and stored only in "designated areas." When these materials are actually in use in the designated area, personnel shall restrict access to this area, or to the part of the designated area in which the materials are in use, by posting a sign at each entrance that states:

RESTRICTED ACCESS

DESIGNATED AREA FOR WORK WITH PARTICULARLY HAZARDOUS SUBSTANCES

AREA MAY CONTAIN: 'SELECT CARCINOGENS', REPRODUCTIVE TOXINS, OR SUBSTANCES WITH A HIGH DEGREE OF ACUTE TOXICITY

Areas in which particularly hazardous substances are stored shall be clearly labeled with appropriate warning signs that indicate the hazard. Containers that are used for carcinogens shall be so labeled.

Laboratory workers who work with particularly hazardous substances shall:

- Leave protective clothing in the designated area during work breaks.
- Wash their hands thoroughly before leaving the designated area.
- Use catch pans or other containment measures to protect work surfaces and to contain spills. (Work surfaces should be constructed of nonporous materials.)
- Use extreme caution while handling these substances, and keep the quantities and frequency of use to an absolute minimum.

After the use of particularly hazardous substances, other operations are allowed in that area only after the area has been decontaminated. Personnel who conducted the experiments shall decontaminate the designated area by:

- Using adequate personal protective equipment during all stages of decontamination.
- Thoroughly washing and rinsing work surfaces with appropriate solvents or solutions (e.g., triple rinsing the surface).
- Decontaminating equipment or materials before removal from the designated area or disposing of them as hazardous material.



Work with particularly hazardous substances may require personnel to enter a medical surveillance program. See MN471001, *ES&H Manual, Chapter 16*, "Benefits and Medical Services," for further guidance. Personnel should contact the Health Services Department (8527) or their department manager for details.

## 8.5 Sensitive Chemicals

Use of sensitive chemicals should be held to a minimum. Their use requires an active inventory procedure. All withdrawals from stock shall be noted and the notation signed by the person making the withdrawal. Department managers shall be responsible for an annual physical verification of inventory and records. Other legal restrictions may also apply to the use of certain sensitive chemicals.

## 8.6 Gases

The use of compressed gases is governed by [MN471000](#), *Pressure Safety Manual*. A number of gases present chemical hazards. [Attachment P](#) lists common gases and their associated hazards. Use of gases that are toxic or corrosive requires a separate ES&H TWD. Personnel should purchase only pressurized containers that can be returned to the vendor. If this is impossible, personnel should contact the Environmental Operations Department (8516).

## 8.7 Radioactive Materials

Requirements for the use of radioactive liquids, solids, or gases are not included in this document. Such usage requires a separate ES&H TWD. Radioactive materials shall not be brought into a chemical laboratory without permission from the Health and Safety Department (8517). See [MN471016](#), *Radiological Protection Procedures Manual*, for more information.

Generation of mixed chemical and radioactive waste requires prior approval from the vice president. Contact the Environmental Operations Department (8516) for information on this approval process. Precautions shall be taken in all operations to avoid the generation of mixed waste.

## 8.8 Personnel Exposures

A variety of chemicals are regulated under [29 CFR 1910.1000](#). Work with these materials shall conform to OSHA PELs or ACGIH TLVs. Normally, this means using these materials in an operating fume hood. If in doubt, personnel should contact an industrial hygienist in the Health and Safety Department (8517) to evaluate exposure in chemical handling operations.

## 8.9 Synthesized, Formulated, or Modified Materials

Unique chemical compounds or chemical mixtures that have been formulated on site may require an MSDS. Laboratory workers should contact an industrial hygienist the Health and Safety Department (8517) for further information. All personnel preparing such materials shall have training in the requirements of the Toxic Substances Control Act (TSCA).

Chemical containers for chemicals synthesized, formulated, or modified by SNL must be barcoded and labeled with the same information that is required for manufacturers' labels (see "[6.1 General Guidelines](#)").

For chemicals synthesized on site, labels should indicate the date prepared and the name of the person responsible for the item. The originator should include as much information about the identity of the item (and its hazards) as possible, including lab references to lab notebooks, where appropriate. The same labeling requirements apply to

unknown materials provided for chemical analysis. Personnel should not accept unknown materials/chemicals unless they are properly labeled.

## 8.10 Medical Surveillance

The Benefits & Health Services Department (8527) must perform medical surveillance tailored to monitor the medical effects of exposure to specific chemicals used in the workplace. Personnel who feel that increased medical monitoring is warranted should talk to their department manager and the Benefits & Health Services Department (8527) about changing their monitoring program.

See PN471001, *Corporate Chemical Hygiene Plan*, (applies to OSHA Laboratory Standard locations) for more information.

# 9.0 EMERGENCY PROCEDURES

## 9.1 Chemical Spills

For guidance on reporting and cleaning up chemical spills, see MN471001, *ES&H Manual*, Chapter 10, [Section E](#), "Chemical Spills." Call the ES&H Hotline at 294-3724 for assistance on spill cleanup and reporting.

## 9.2 Accidents and Medical Emergencies

In the event of an accident or medical emergency, personnel shall take the following actions:

Step	Action
1	Dial 911. The appropriate medical, ES&H, and security personnel will be contacted simultaneously.
2	If injuries are the result of hazardous substances, remove the source of the injury (e.g., set chemical container upright, close valve) if this can be accomplished without further risk to personnel.
3	Remove the victim to a safe area if circumstances and injuries allow such action.
4	Notify the department manager and provide information to the center director.

## 9.3 Explosions and Fires

Personnel shall take the following actions:

**Warning:** In some buildings, activation of an outside fire alarm does not sound an inside alarm.

Step	Action
1	Dial 911. If a phone is not accessible or the building needs to be evacuated, pull a fire alarm box. The appropriate medical, ES&H, and security personnel will be contacted simultaneously.
2	Notify the department manager and provide information to the center director.

## 9.4 Earthquakes

During an earthquake, laboratory workers must immediately stop all operations, secure any hazardous chemicals in use, and move to a safer area. After the earthquake subsides, laboratory workers should:



Step	Action
1	Quickly inspect their immediate area to ensure that hazardous materials are secured and do not pose a threat to personnel.
2	Evacuate the building. Do not use fire alarm pull boxes to evacuate the building during an earthquake, unless there is an actual fire.
3	If there is a chemical hazard that cannot be safely dealt with, immediately call 911. If the phone system is not functioning, inform the building emergency team leader.
4	Before resuming any work, ensure all experimental operations are checked by the principal investigator. ES&H assistance may be requested.

## 10.0 WASTE STORAGE AND DISPOSAL

See GN470075, *Guidelines for Hazardous Waste Generators at SNL/CA*, for comprehensive guidelines for generators of hazardous waste at SNL/CA.

Contact Hazardous & Radioactive Waste in the Environmental Operations Department (8516) at 294-2145 for answers to waste questions.

## 11.0 REFERENCES

### Requirements Source Documents

16 CFR 1500.45, *Method for Determining Extremely Flammable and Flammable Contents of Self-Pressurized Containers*.

[29 CFR 1910](#), Subpart Z, *Toxic and Hazardous Substances*.

American Conference of Governmental Industrial Hygienists (ACGIH), *1996 TLVs® and BEIs®: Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices*, Cincinnati, OH, 1996 or latest edition.

California Code of Regulations, Title 22, *Social Security*, Division 4.5, "Environmental Health Standards for the Management of Hazardous Waste."

[DOE 5480.4](#), *Environmental Protection, Safety, and Health Protection Standards*.

International Agency for Research on Cancer (IARC), et al., ad-hoc working group on the evaluation of carcinogenic risks to humans, *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, 1987.

National Toxicology Program (NTP) (see U.S. Department of Health and Human Services).

U.S. Department of Health and Human Services, *Annual Report on Carcinogens*, National Toxicology Program (NTP), Fifth Edition, U. S. Department of Commerce National Technical Information Service (NTIS), 1989.

### Implementing Documents



SNL, [GN470075](#), *Guidelines for Waste Generators at SNL/CA*.

SNL, [GN470098](#), *Developing ES&H Procedures*.

SNL, [MN471000](#), *Pressure Safety Manual*.

SNL, [MN471016](#), *Radiological Protection Procedures Manual*.

SNL, [PN471001](#), *Corporate Chemical Hygiene Plan*, March 5, 1991.

## Related Documents

Accrocco, J. O., ed., *The MSDS Pocket Dictionary*, Genium Publishing Corporation, 1988.

ANSI Z87.1A-1989, *Occupational and Educational Eye and Face Protection*.

Barnhard, Edward R., *Physicians' Desk Reference*, 1987.

Bretherick, L., *Handbook of Reactive Chemical Hazards*, Second Edition, Billing and Sons Ltd., 1979.

Bretherick, L., ed., *Hazards in the Chemical Laboratory*, Fourth Edition, The Royal Society of Chemistry, 1986.

Committee on Hazardous Substances in the Laboratory, et al., *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, National Academy Press, 1981.

Dux, J. P., and R. F. Stalzer, *Managing Safety in the Chemical Laboratory*, Van Nostrand Reinhold Company, Inc., 1988.

International Technical Information Institute, *Toxic and Hazardous Industrial Chemicals Safety Manual*, 1986.

Kaufman, J. A., *Waste Disposal in Academic Institutions*, Lewis Publishers, Inc., 1990.

Klaassen, C. D., M. O. Amdur, J. Doull, ed., *Casarett and Doull's TOXICOLOGY: The Basic Science of Poisons*, Third Edition, Macmillan Publishing Company, 1986.

Lenga, R. E., ed., *Sigma-Aldrich Library of Chemical Regulatory and Safety Data*, Sigma-Aldrich Corporation, 1994.

Lunn, G., and E. B. Sansone, *Destruction of Hazardous Chemicals in the Laboratory*, John Wiley and Sons, Inc., 1990.

Pipitone, D. A., ed., *Safe Storage of Laboratory Chemicals*, John Wiley and Sons, Inc., 1984.

Pitt, M. J., and E. Pitt, *Handbook of Laboratory Waste Disposal*, Ellis Horwood, Ltd., 1985.

Sax, N. I., *Dangerous Properties of Industrial Materials*, Van Nostrand Reinhold Company, Inc., 1992.

Sax, N. I., and R. J. Lewis, Sr., eds., *Rapid Guide to Hazardous Chemicals in the Workplace*, Van Nostrand Reinhold Company, Inc., 1986.

Shane, B. S., *Human Reproductive Hazards*, Environmental Science & Technology, Volume 23, Number 10, 1989.

Sitting, M., *Handbook of Toxic and Hazardous Chemicals and Carcinogens*, Second Edition, Noyes Publications, 1985.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)





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## CHANGE HISTORY

### GN470094, *Handling Chemicals at SNL/CA*

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#### Administrative Changes June 29, 2005

This document was administratively revised to:

- **Change:** Executive Policy Sponsor from Les Shephard to Frank Figueroa
- 

#### Administrative Changes November 8, 2004

This section was revised to:

- **Add.** The subtopic, "Applicability."
  - **Delete.** The subtopic, "Scope," and move its text under the subtopic, "Purpose."
- 

#### August 5, 2003

This document has been revised to:

- **Change:**
  - In topic 5.4, "Safety Showers and Eyewashes," extend the testing interval for safety showers from each week to each month and require generation and maintenance of documentation of the tests.
  - In topic 7.5, "Peroxidizable Chemicals," in the sentence, "Opened peroxidizable chemicals shall have a shelf life of 12 months if stored at room temperature or above," change "Opened peroxidizable chemicals..." to "Unopened peroxidizable chemicals..."



- Update organizations

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## Administrative Changes November 4, 2002

This document has been administratively revised to:



- **Change:**

- In section 7.5, "Peroxidizable Chemicals," in the sentence, "Opened peroxidizable chemicals shall have a shelf life of 12 months if stored at room temperature or above," change "Opened peroxidizable chemicals..." to "Unopened peroxidizable chemicals..."



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)





# ATTACHMENT A - SENSITIVE CHEMICALS

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

Revision Date: [August 5, 2003](#), Replaces Document Dated: March 20, 1997

Administrative Changes: November 4, 2004 and [June 29, 2005](#)

Chemical Name	Type of Control	
	California	Federal
N-Acetylanthranilic acid	X	
Amphetamine		X
Anthranilic acid	X	
Barbituric acid	X	
Cocaine		X
Diethyl malonate	X	
Ephedrine	X	
Ergotamine tartrate	X	
Ethylamine	X	
Ethyl malonate	X	
Fentanyl		X
D-Lysergic acid	X	X
Lysergic acid diethylamide (LSD)		X
Malonic acid	X	
Methamphetamine		X
Methaqualone		X
Methaqualude		X
Methylamine	X	

3,4-Methylenedioxyamphetamine		X
3,4-Methylenedioxymethamphetamine		X
Morpholine	X	
Norpseudoephedrine	X	
Pentobarbital		X
Phencyclidine (PCP)		X
Phenylacetic acid	X	
Phenylpropanolamine	X	
1-Phenyl-2-propanone (P2P)	X	X
Piperidine	X	X
Pseudoephedrine	X	
Pyrrolidine	X	
Secobarbital		X



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT B - CLASSIFICATION OF TOXINS, PROBABLE ORAL LETHAL DOSE (HUMAN)\*

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

Revision Date: [August 5, 2003](#), Replaces Document Dated: March 20, 1997

Administrative Changes: November 4, 2004 and [June 29, 2005](#)

Toxicity Rating	Dose	For 70kg (150-lb) Person
6, super toxic	Less than 5 mg/kg	A taste (less than 7 drops)
5, extremely toxic	5 to 50 mg/kg	Between 7 drops and 1 teaspoon
4, very toxic	50 to 500 mg/kg	Between 1 teaspoon and 1 ounce
3, moderately toxic	0.5 to 5 g/kg	Between 1 ounce and 1 pint
2, slightly toxic	5 to 15 g/kg	Between 1 pint and 1 quart
1, practically nontoxic	More than 15 g/kg	More than 1 quart (or 1 kg)

\*C. D. Klaassen, M. O. Amdur, J. Doull, ed., *Casarett and Doull's TOXICOLOGY: The Basic Science of Poisons*, Third Edition, Macmillan Publishing Company, 1986, p. 13.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT C - CONTAINER SIZES FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

Revision Date: [August 5, 2003](#), Replaces Document Dated: March 20, 1997

Administrative Changes: November 4, 2004 and [June 29, 2005](#)

## Flammable Liquids:

Type of Container	Class IA		Class IB		Class IC	
	Liters	Gallons	Liters	Gallons	Liters	Gallons
Glass	0.5	0.12	1	0.25	4	1
Metal (other than DOT drums)	4	1	20	5	20	5
Safety cans	7.5	2	20	5	20	5
Metal drums (DOT specifications) <sup>a</sup>	225	60	225	60	225	60
Approved portable tanks <sup>b</sup>	2500	660	2500	660	2500	660

## Combustible Liquids:

Type of Container	Class II		Class IIA	
	Liters	Gallons	Liters	Gallons
Glass	4	1	4 <sup>c</sup>	1 <sup>c</sup>
Metal (other than DOT drums)	20	5	20	5
Safety cans	20	5	20	5
Metal drums (DOT specifications) <sup>a</sup>	225	60	225	60
Approved portable tanks <sup>b</sup>	2500	660	2500	660

<sup>a</sup>Maximum size permitted in a laboratory for class I materials is 20 liters (5 gallons); drum size is permitted only in an inside storage room

<sup>b</sup>Permitted only outside of buildings

<sup>c</sup>OSHA limitation





[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT D - FLASH POINTS OF COMMON CLASS IA FLAMMABLE LIQUIDS\*

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

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Flammable Liquid	Flash Point (°F)
Ethyl chloride	-58
Pentane	-57
Ethyl ether	-49
Acetaldehyde	-36
Isopropylamine	-35
Ethyl formate	-2
Ethylamine	0

\* Flash point less than 73°F; boiling point less than 100°F



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT E - FLASH POINTS OF COMMON CLASS IB FLAMMABLE LIQUIDS\*

Subject Matter Expert: [Jenifer Leon](#)

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Flammable Liquid	Flash Point (°F) <sup>a</sup>
Naphtha <sup>b</sup>	-40 to 68
Allyl chloride	-25
Carbon disulfide	-22
Isopropyl ether	-18
Acrolein	-15
Ethyl bromide	-9
Hexane	-7
Cyclohexane	-4
Nickel carbonyl	-4
Acetone	1.4
1,1-Dimethylhydrazine	5
Tetrahydrofuran	6
Butyl amine	10
Benzene	12
Methyl acetate	14
Methyl ethyl ketone	21
Ethyl acetate	24
Heptane	25

Acrylonitrile	30
Butyl mercaptan	35
Toluene	40
2-Pentanone	45
Methyl methacrylate	50 (oc)
Methanol	5228
Isopropanol	53
Dioxane	54
Ethylene dichloride	55
Octane	56
Propanol	59
sec-butyl acetate	62
Pyridine	68
Allyl alcohol	70
Butyl acetate	72

\*Flash point less than 73°F; boiling point greater than or equal to 100°F

<sup>a</sup>Closed-cup values are given unless where denoted by "oc" (open cup)

<sup>b</sup>Borderline class IA



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT F - FLASH POINTS OF COMMON CLASS IC FLAMMABLE LIQUIDS\*

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

Revision Date: [August 5, 2003](#), Replaces Document Dated: March 20, 1997

Administrative Changes: November 4, 2004 and [June 29, 2005](#)

Flammable Liquid	Flash Point (°F)
Methyl isobutyl ketone	73
2-Butanol	75
n-Amyl acetate	77
2-Hexanone	77
Isoamyl acetate	77
Xylene	81
Butyl alcohol	84
Chlorobenzene	84
p-Ansidine	86
sec-Amyl acetate	89
Styrene	90
Ethylene diamine	93
Morpholine	95
Turpentine	95

\*Flash point greater than or equal to 73°F, but less than 100°F



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



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# ATTACHMENT G - EXPLOSIVE CHEMICALS

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Subject Matter Expert: [Jenifer Leon](#)


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The following may be supplied as laboratory reagents, pharmaceuticals, or polymer components. However, they are in fact explosives. Appropriate care should be taken in storage and disposal, especially if they have deteriorated in any way.



- Acetylene
- Acetyl peroxide
- Ammonium nitrate
- Ammonium picrate
- Benzoyl peroxide
- Cumene peroxide
- Dinitrophenylhydrazine
- Dipicrylamine
- Dipicryl sulphide
- Ethylene oxide
- Lauric peroxide
- Methyl ethyl ketone peroxide
- Nitrogen trifluoride
- Nitroglycerin
- Nitroguanidine
- Nitromethane
- Picramide
- Picric acid
- Picryl chloride
- Picryl sulphonic acid
- Propargyl bromide
- Succinic peroxide

Trinitroanisole  
Trinitrobenzene  
Trinitrobenzene sulphonic acid  
Trinitrobenzoic acid  
Trinitrocresol  
Trinitronaphthalene  
Trinitrophenol  
Trinitroresorcinol  
Trinitrotoluene  
Urea nitrate



[Jenifer Leon, jleon@sandia.gov](mailto:jleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)







# ATTACHMENT H - INCOMPATIBLE CHEMICALS



Subject Matter Expert: [Jenifer Leon](#)

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## Classes of Incompatible Chemicals<sup>a</sup>:

Class A	Class B
<b>Acids</b>	<b>Bases</b>
 Alkali and alkaline earth metals <ul style="list-style-type: none"> <li>• Carbides</li> <li>• Hydrides</li> <li>• Hydroxides</li> <li>• Oxides</li> <li>• Peroxides</li> </ul> 	Water Acids Halogenated organic compounds Oxidizing agents <sup>b</sup> <ul style="list-style-type: none"> <li>• Chromates, dichromates, CrO<sub>3</sub></li> <li>• Halogens</li> <li>• Halogenating agents</li> <li>• Hydrogen peroxide and peroxides</li> <li>• Nitric acid, nitrates</li> <li>• Perchlorates and chlorates</li> <li>• Permanganates</li> <li>• Persulfates</li> </ul>
Inorganic azides	Acids Heavy metals and their salts Oxidizing agents <sup>b</sup>
Inorganic cyanides	Acids, strong bases
Inorganic nitrates	Acids Metals Nitrites Sulfur

Inorganic nitrites	Acids Oxidizing agents <sup>b</sup>
Inorganic sulfides	Acids
Organic compounds <ul style="list-style-type: none"> <li>Organic acyl halides</li> <li>Organic anhydrides</li> <li>Organic halogen compounds</li> <li>Organic nitro compounds</li> </ul>	Oxidizing agents <sup>b</sup> Bases Organic hydroxy compounds Bases Organic hydroxy compounds Aluminum metal Strong bases
Powdered metals	Acids Oxidizing agents <sup>b</sup>

### Specific Chemical Incompatibilities<sup>a</sup>:

Chemical A	Chemical B
Acetylene and monosubstituted acetylene R - C __ C-H	Halogens Group IB and IIB metals and their salts
Ammonia and NH <sub>4</sub> OH	Halogens Halogenating agents Silver Mercury
Carbon, activated	Oxidizing agents <sup>b</sup>
Hydrogen peroxide	Metals and their salts
Nitric acid	Metals Sulfuric acid Sulfides Nitrites, other reducing agents Chromic acid and chromates Permanganates
Mercury and its amalgams	Ammonia and NH <sub>4</sub> OH Nitric acid Acetylene Sodium azide
Oxalic acid	Silver Mercury
Phosphorus (yellow)	Oxygen Oxidizing agents <sup>b</sup> Strong bases
Phosphorus pentoxide	Water Halogenating agents

Sulfuric acid

Metals  
Chlorates  
Perchlorates  
Permanganates  
Nitric acid

<sup>a</sup>Chemicals in columns A and B should be kept separate.

<sup>b</sup>Oxidizing agents include the types of compounds listed in the entry for alkali and alkaline earth metals, etc.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



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# ATTACHMENT I - DETERIORATING CHEMICALS

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Subject Matter Expert: [Jenifer Leon](#)

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The following is a selection of chemical substances which can deteriorate to a dangerous condition with age under common storage conditions. The degree of the hazard will vary considerably with age and the exact situation, but it is advisable to take precautions when discarding, recycling, or otherwise handling old samples.

The chemical name is followed by a code indicating the deterioration description.

Acetal (3)	Di-iso-butyl ether (2)
Acetaldehyde diethyl acetal (3)	Di-n-butyl ether (3)
2-Acetyl furan (3)	Dicyclopentadiene (3)
Acetyl peroxide (1)	1,1-Diethoxyethane (3)
Aluminium chloride (5)	Diethylacetal (3)
Aluminium lithium hydride (5)	Diethyl azidoformate (4)
Ammonia solution (5)	Diethyl azodicarboxylate (1)
Ammonium dichromate (4)	Diethylene glycol dimethyl ether (3)
Ammonium hydroxide (5)	Diethyl ether (3)
Ammonium persulphate (5)	Diglyme (3)
Anethole (3)	Dihydropyran (3)
Anisaldehyde (3)	1,2-Dimethoxyethane (3)
Anisole (3)	Dimethoxymethane (3)
Anisyl chloride (5)	Dimethylamine (5)
Aqua regia (5)	2,4-Dinitrophenol (1)
	2,4-Dinitrophenylhydrazine (1)
Benzenesulphonyl chloride (5)	1,4-Dioxan (3)
Benzoyl peroxide (1)	Diphenyl ether (3)
Bleach (5)	Di-iso-propyl ether (2)
Bleaching powder (5)	Di-n-propyl ether (3)
2-(2-Butoxyethoxy)ethyl acetate (3)	
2-Butoxyethyl acetate (3)	Ether (3)
t-Butyl hydroperoxide (4)	Ethyl cellosolve (3)
iso-Butyl ether (2)	Ethylene glycol dimethyl ether (3)
n-Butyl ether (3)	Ethylene glycol ethyl ether acetate (3)
n-Butyl glycidyl ether (3)	Ethylene glycol monobutyl ether (3)
	Ethylene glycol monoethyl ether (3)
Calcium carbide (5)	Ethylene glycol monomethyl ether (3)
Calcium hydride (5)	Ethyl ether (3)
Calcium hypochlorite (5)	2-Ethoxyethanol (3)
Cellosolve (3)	2-Ethoxyethyl acetate (3)
Chloroform (5)	Ethyl vinyl ether (2)
Chromic acid (5)	
Chromium trioxide (4)	Formic acid (100%) (5)
Cleaning mixtures (5)	Furan (3)
Cumene (3)	
Cumene hydroperoxide (5)	Glycidyl n-butyl ether (3)
Cyclohexene (3)	Glyme (3)
Cyclopentadiene (3)	
Cyclopentene (3)	Hydrogen peroxide (5)
Decahydronaphthalene (3)	
Decalin (3)	Iodine pentoxide (4)
Di-allyl ether (3)	Isoamyl ether (3)
Di-iso-amyl ether (3)	Isobutyl ether (2)
Dibenzyl ether (3)	Isopentyl ether (3)
	Isopropyl alcohol (3)

## ATTACHMENT I - DETERIORATING CHEMICALS (Cont'd)

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Isopropyl ether (2)  
Isopropyl benzene (3)

Lauroyl peroxide (5)  
Lithium aluminium hydride (5)  
Lithium hydride (5)

Magnesium perchlorate (4)  
Mercury fulminate (1)  
2-Methoxyethanol (3)  
Methylal (3)  
Methyl cellosolve (3)  
Methyl iso-butyl ketone (3)  
Methyl ethyl ketone peroxide (1)  
Methyl vinyl ketone (3)

Nitric acid (5)  
Nitromethane (1)  
Nitrosoguanidine (5)

Peracetic acid (1,4,5)  
Perchloric acid (4)  
Phosphorus trichloride (5)  
Picric acid (1)  
Picryl chloride (1)  
Picryl sulphonic acid (1)  
Potassium (metal) (1)  
Potassium amide (1)  
Potassium chlorate (4)  
Potassium perchlorate (4)  
Potassium persulphate (5)  
Propan-2-ol (3)  
Propargyl bromide (1)  
Propargyl chloride (1)

Silicon tetrachloride (5)  
Silvering solution (1)  
Sodamide (1)  
Sodium amide (1)  
Sodium borohydride (5)  
Sodium chlorate (4)  
Sodium chlorite (4)  
Sodium dithionite (5)  
Sodium hydride (5)  
Sodium hydrosulphite (5)  
Sodium hypochlorite (5)  
Sodium metal dispersions (1)  
Sodium perchlorate (4)  
Sodium peroxide (5)  
Sodium persulphate (5)  
Styrene (3)

Tetrahydrofuran (3)  
Tetralin (3)  
Thionyl chloride (5)  
Trinitrobenzene (1)

Trinitrobenzene sulphonic acid (1)

Urea nitrate (4)  
Urea peroxide (5)

Vinyl acetate (3)  
Vinylidene chloride (1)  
Vinyl pyridine (3)

Zinc (5)

## ATTACHMENT I - DETERIORATING CHEMICALS (Cont'd)

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**\*Key:**

- (1) Can deteriorate to a shock-sensitive explosive. Take exceptional care if there is evidence of drying out, crystallization or contamination. It may be very dangerous to attempt to open the container.
- (2) Forms peroxides, especially on exposure to air and light, making the material liable to explode. This class is so dangerous that it should not normally be distilled unless it has been very well controlled. Material more than one year old should be discarded, even if unopened. Containers should not be opened if there is any solid visible around the closure or any evidence of crystals inside.
- (3) Also forms peroxides. If very old or obviously in poor condition, treat as (2). Otherwise, take care to test for peroxides before use or recovery procedures.
- (4) High energy materials which are sensitive to the presence of dust. Clean the outside of containers before opening. If in doubt, do not open. Mixtures of the material with dust, paper, or organics may ignite or detonate when exposed to friction, e.g. on the threads of a screw-capped container.
- (5) Containers may have a high internal gas pressure owing to decomposition. Open carefully behind a safety shield in a fume hood.

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# ATTACHMENT J - INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC) LIST OF CHEMICAL CARCINOGENS

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Subject Matter Expert: [Jenifer Leon](#)

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## Group 1: Causally associated with cancer in humans



### *Industrial processes and occupational exposures:*

- Auramine manufacture
- Boot and shoe manufacture and repair (certain occupations)
- Furniture manufacture
- Isopropyl alcohol manufacture (strong-acid process)
- Nickel refining
- Rubber industry (certain occupations)
- Underground haematite mining (with exposure to radon)

### *Chemicals and groups of chemicals:*



- 4-Aminobiphenyl
- Analgesic mixtures containing phenacetin<sup>a</sup>
- Arsenic and arsenic compounds<sup>a</sup>
- Asbestos
- Azathioprine
- Benzene
- Benzidine
- N,N-Bis(2-chloroethyl-2-naphthylamine (Chlornaphazine)

Bis(chloromethyl)ether and technical-grade chloromethyl methyl ether  
1,4-Butanediol dimethanesulphonate (Myleran)

Certain combined chemotherapy for lymphomas<sup>a</sup> (including MOPP<sup>b</sup>)

Chlorambucil

Chromium and certain chromium compounds<sup>a</sup>

Conjugated oestrogens<sup>a</sup>

Cyclophosphamide

Diethylstilboestrol

Melphalan

Methoxsalen with ultraviolet A therapy (PUVA)

Mustard gas

2-Naphthylamine

Soots, tars and oils<sup>a,c</sup>

Treosulphan

Vinyl chloride

**Group 2: The following 61 chemicals, groups of chemicals, or industrial processes are probably carcinogenic to humans**

### ***Group 2A***

Acrylonitrile

Aflatoxins

Benzo[a]pyrene

Beryllium and beryllium compounds<sup>a</sup>

Combined oral contraceptives<sup>a</sup>

Diethyl sulphate

Dimethyl sulphate

Manufacture of magenta<sup>a</sup>

Nickel and certain nickel compounds

Nitrogen mustard

Oxymetholone

Phenacetin




Procarbazine

*ortho*-Toluidine

### ***Group 2B***







Actinomycin D  
Adriamycin  
Amitrole  
Auramine (technical grade)  
Benzotrichloride  
Bischloroethyl nitrosourea (BCNU)  
Cadmium and cadmium compounds  
Carbon tetrachloride  
Chloramphenicol  
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)  
Chloroform  
Chlorophenols (occupational exposure to) [a](#)  
Cisplatin  
Dacarbazine  
DDT  
3,3'-Dichlorobenzidine  
Dienoestrol  
3,3'-Dimethoxybenzidine (*ortho*-Dianisidine)  
Dimethylcarbamoyl chloride  
1,4-Dioxane  
Direct Black 38 (technical grade)  
Direct Blue 6 (technical grade)  
Direct Brown 95 (technical grade)  
Epichlorohydrin  
Ethinylloestradiol  
Ethylene dibromide  
Ethylene oxide  
Ethylene thiourea  
Formaldehyde (gas)  
Hydrazine  
Mestranol  
Metronidazole  
Norethisterone  
Oestradiol-17b  
Oestrone  
Phenazopyridine  
Phenytoin  
Phenoxyacetic acid herbicides (occupational exposure to) [a](#)  
Polychlorinated biphenyls  
Progesterone

Propylthiouracil

Sequential oral contraceptives<sup>a</sup>

Tetrachlorodibenzo-*para*-dioxin (TCDD)

2,4,6-Trichlorophenol

Tris(aziridiny-*para*-benzoquinone (Triaziquone)

Tris(1-aziridinyl)phosphine sulphide (Thiotepa)

Uracil mustard



**Notes:**

<sup>a</sup>The compound(s) responsible for the carcinogenic effect in humans cannot be specified.

<sup>b</sup>Procarbazine, nitrogen mustard, vincristine, and prednisone

<sup>c</sup>Mineral oils may vary in composition, particularly in relation to their content of carcinogenic polycyclic aromatic hydrocarbons.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



## ATTACHMENT K - NATIONAL TOXICOLOGY PROGRAM (NTP) LIST OF CHEMICAL CARCINOGENS

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Subject Matter Expert: [Jenifer Leon](#)

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### Substances or groups of substances, and technical processes that are known to be carcinogenic:

4-Aminobiphenyl	Hematite underground mining
Analgesic mixtures containing phenacetin	
Arsenic and certain arsenic compounds	Isopropyl alcohol manufacturing (strong-acid process)
Asbestos	
Azathioprine	
	Manufacture of auramine
Benzene	Melphalan
Benzidine	Methoxsalen with ultraviolet A therapy (PUVA)
N,N-bis(2-chloroethyl)-2-naphthylamine (chlornaphazine)	Mustard gas
Bis(chloromethyl)ether and technical grade chloromethyl methyl ether	2-Naphthylamine
1,4-Butanediol dimethylsulfonate (myleran)	Nickel refining
	Rubber industry (certain occupations)
Certain combined chemotherapy for lymphomas	
Chlorambucil	Soots, tars, and mineral oils
Chromium and certain chromium compounds	
Coke oven emissions	Thorium dioxide
Conjugated estrogens	
Cyclophosphamide	Vinyl chloride
Diethylstilbestrol	

### Substances or groups of substances that may reasonably be anticipated to be carcinogens:

2-Acetylaminofluorene	Chloroform
Acrylonitrile	4-Chloro-o-phenylenediamine
Adriamycin	p-Cresidine
Aflatoxins	Cupferron
2-Aminoanthraquinone	Cycasin
1-Amino-2-methylanthraquinone	
Amitrole	Dacarbazine
o-Anisidine and o-anisidine hydrochloride	DDT
Aramite (Reg TM)	2,4-Diaminoanisole sulfate
	2,4-Diaminotoluene
Benz(a)anthracene	Dibenz(a,h)acridine
Benzo(b)fluoranthene	Dibenz(a,j)acridine
Benzo(a)pyrene	Dibenz(a,h)anthracene
Benzotrichloride	7H-Dibenzo(c,g)carbazole
Beryllium and certain beryllium compounds	Dibenzo(a,h)pyrene
Bischloroethyl nitrosourea	Dibenzo(a,i)pyrene
	1,2-Dibromo-3-chloropropane
Cadmium and certain cadmium compounds	1,2-Dibromoethane (EDB)
Carbon tetrachloride	3,3'-Dichlorobenzidine
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	1,2-Dichloroethane
	Diepoxybutane

## ATTACHMENT K - NATIONAL TOXICOLOGY PROGRAM (NTP) LIST OF CHEMICAL CARCINOGENS (Cont'd)

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Di(2-ethylhexyl)phthalate  
Diethyl sulfate  
3,3'-Dimethoxybenzidine  
4-Dimethylaminoazobenzene  
3,3'-Dimethylbenzidine  
Dimethylcarbamoyl chloride  
1,1-Dimethylhydrazine  
Dimethyl sulfate  
1,4-Dioxane  
Direct Black 38  
Direct Blue 6

Epichlorohydrin  
Estrogens (not conjugated): 1. Estradiol 17b  
Estrogens (not conjugated): 2. Estrone  
Estrogens (not conjugated): 3. Ethinylestradiol  
Estrogens (not conjugated): 4. Mestranol  
Ethylene oxide  
Ethylene thiourea

Formaldehyde (gas)

Hexachlorobenzene  
Hexamethylphosphoramide  
Hydrazine and hydrazine sulfate  
Hydrazobenzene

Indeno(1,2,3-cd)pyrene  
Iron dextran complex

Kepone (Reg TM) (Chlordecone)

Lead acetate and lead phosphate  
Lindane and other hexachlorocyclohexane isomers

2-Methylaziridine (propyleneimine)  
4,4'-Methylenebis(2-chloroaniline) (MBOCA)  
4,4'-Methylenebis(N,N-dimethyl)benzenamine  
4,4'-Methylenedianiline and its dihydrochloride  
Methyl iodide  
Metronidazole  
Michler's ketone  
Mirex

Nickel and certain nickel compounds  
Nitritotriacetic acid  
5-Nitro-o-anisidine  
Nitrofen  
Nitrogen mustard  
2-Nitropropane

N-Nitrosodi-n-butylamine  
N-Nitrosodiethanolamine  
N-Nitrosodiethylamine  
N-Nitrosodimethylamine  
p-Nitrosodiphenylamine  
N-Nitrosodi-n-propylamine  
N-Nitroso-N-ethylurea  
N-Nitroso-N-methylurea  
N-Nitrosomorpholine  
N-Nitrosornicotine  
N-Nitrosopiperidine  
N-Nitrosopyrrolidine  
N-Nitrososarcosine  
Norethisterone

Oxymetholone

Phenacetin  
Phenazopyridine hydrochloride  
Phenytoin and sodium salt of phenytoin  
Polybrominated biphenyls  
Polychlorinated biphenyls  
Procarbazine and procarbazine hydrochloride  
Progesterone  
1,3-Propane sultone  
b-Propiolactone  
Propylthiouracil

Reserpine

Saccharin  
Safrole  
Selenium sulfide  
Streptozotocin Sulfallate

2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)  
Thioacetamide  
Thiourea  
Toluene diisocyanate  
o-Toluidine and o-toluidine hydrochloride  
Toxaphene  
2,4,6-Trichlorophenol  
Tris(1-aziridiny)phosphine sulfide  
Tris(2,3-dibromopropyl)phosphate

Urethane

## ATTACHMENT L – CHEMICALS ‘KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER’

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Subject Matter Expert: [Jenifer Leon](#)

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Acetaldehyde	Chlordane
Acetochlor	Chlordecone (Kepone [Reg TM])
Acetylaminofluorene	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)
Acrylonitrile	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)
Adriamycin	Chlordimeform
AF-2; [2-(2-fluryl)-3-(5-nitro-2-furyl)]acrylamide	Chloroform
Aflatoxins	Chloromethyl methyl ether (technical grade)
Alachlor	4-Chloro-ortho-phenylenediamine
Alcoholic beverages (when associated with alcohol abuse)	Chlorothalonil
Aldrin	Chromium (hexavalent compounds)
ortho-Aminoazotoluene	Coke oven emissions
2-Amino-5-(5-nitro-2-furyl) -1,3,4-thiodiazole	Conjugated estrogens
4-Aminobiphenyl	Creosotes
Amitrole	para-Cresidine
ortho-Anisidine and ortho-Anisidine hydrochloride	Cupferron
Analgesic mixtures containing phenacetin	Cycasin
Aramite (Reg TM)	Cyclophosphamide
Arsenic (inorganic arsenic compounds)	
Asbestos	Dacarbazine
Auramine	Daunomycin
Asaserine	DDD (Dichlorodiphenyldichloroethane)
Asathioprine	DDE (Dichlorodiphenyldichloroethylene)
	DDT (1,1,1-Trichloro-2,2-bis (p-chlorophenyl) ethane)
Benz[a]anthracene	Degraded Carrageenan (not food grade)
Benzene	2,4-Diaminoanisole sulfate
Benzidine (and its salts)	4,4'-Diaminodiphenyl ether
Benzo[b]fluoranthene	2, 4'-Dianinotoluene
Benzo[j]fluoranthene	Dibenz[a,h]acridine
Benzo[k]fluoranthene	Dibenz[a,j]acridine
Benzo[a]pyrene	Dibenz[a,h]anthracene
Benzotrichloride	7H-Dibenzo[c,g]carbazole
Benzyl violet 4B	Dibenzo[a,e]pyrene
Beryllium and beryllium compounds	Dibenzo[a,h]pyrene
Bis(2-chloroethyl)ether	Dibenzo[a, i]pyrene
N,N-Bis(2-chloroethyl)-2-naphthylamine	Dibenzo[a,l]pyrene
Bischloroethyl nitrosourea (BCNU)	1,2-Dibromo-3-chloropropane (DBCP)
Bis(chloromethyl)ether	p-Dichlorobenzene
1,3-Butadiene	3,3'-Dichlorobenzidine
1,4-Butanediol dimethanesulfonate (Myleran)	3,3'-Dichloro-4,4'-diaminodiphenyl ether
beta-Butyrolactone	Dichloromethane (Methylene chloride)
	1,3-Dichloropropene
Cadmium and cadmium compounds	Dieldrin
Carbon tetrachloride	Diepoxybutane
Certain combined chemotherapy for lymphomas	Di(2-ethylhexyl) phthalate
Chlorambucil	1,2-Diethylhydrazine

**ATTACHMENT L – CHEMICALS ‘KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER’ (Cont’d)**

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Diethyl sulfate	Lactofen
Diethylstilbestrol	Lasiocarpine
Dihydrosafrole	Lead acetate
3,3'-Dimethoxybenzidine (ortho Dianiasidine)	Lead phosphate
4-Dimethylaminoazobenzene	
trans-2-[(Dimethylamino) methylimino]-5-[2-5-nitro-2-furyl]vinyl]-1,3,4-oxadiazole	Melphalan
3,3'-Dimethylbenzidine (ortho Tolidine)	Merphalan
Dimethylcarbamoyl chloride	Mestranol
1,2-Dimethylhydrazine	Methoxsalen with ultraviolet A therapy (PUVA)
Dimethyl sulfate	2-Methylaziridine (propyleneimine)
2,4-Dinitrotoluene	Methylazoxymethanol
1,4-Dioxane	Methylazoxymethanol acetate
Diphenylhydrazine	5-Methylchrysene
Direct Black 38 (technical grade)	4,4'-Methylene bis(2-chloroaniline)
Direct Blue 6 (technical grade)	4,4'-Methylene bis(2-methylaniline)
Direct Brown 95 (technical grade)	4,4'-Methylenedianiline and its dihydrochloride
	Methyl iodide
Epichlorohydrin	Methyl methanesulfonate
Erionite	2-Methyl-1-nitroanthraquinone (of uncertain purity)
Estradiol 17 B	N-Methyl-N'-Nitro-nitrosoquanidine
Estrone	Metronidazole
Ethinylestradiol	Michler's ketone
Ethylene dibromide	Mirex
1,2-Dichloroethane (Ethylene dichloride)	Mitomycin C
Ethyleneimine	Monocrotaline
Ethylene oxide	5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)-amino]-2-oxalolidinone
Ethylene thiourea	Mustard gas
Ethyl methanesulfonate	
	Nafenopin
Folpet	2-Naphthylamine
Formaldehyde (gas)	Nickel refinery dust from the pyrometallurgical process
Formylhydrozino-4-(5-nitro-2-furyl)thiazole	Nickel carbonyl
	Nickel subsulfide
Glycialdehyde	Niridazole
Gyromitrin (acetaldehyde methylformylhydrazone)	Nitrilotriacetic acid
	4-Nitrobiphenyl
Heptachlor	5-Nitroacenaphthene
Heptachlor epoxide	Nitrofen (technical grade)
Hexachlorobenzene	1-[(5 Nitrofurfurylidene)-amIno]-2-imidazolidinone
Hexachlorocyclohexane (technical grade)	N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide
Hexachlorodibenzodioxin	Nitrogen mustard
Hexamethylphosphoramide	Nitrogen mustard hydrochloride
Hydrazine and hydrazine sulfate	Nitrogen mustard N-oxide and its hydrochloride
Hydrazobenzene	2-Nitropropane
	N-Nitrosodi-n-butylamine
Indeno [1,2,3-cd]pyrene	N-Nitrosodiethanolamine
Iron dextran complex	N-Nitrosodiethylamine
	N-Nitrosodimethylamine
	p-Nitrosodiphenylamine
	N-Nitrosodi-n-propylamine
	N-Nitro-diphenylamine
	N-Nitroso-N-ethylurea

## ATTACHMENT L – CHEMICALS ‘KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER’ (Cont’d)

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N-Nitroso-N-methylurea	Taxaphene (polychlorinated camphenes)
N-Nitroso-N-methylurethane	Treosulfan
N-Nitrosomethylvinylamine	2,4,6-Trichlorophenol
N-Nitrosomorpholine	Trichloroethylene
N-Nitrosornicotine	Tris(1-aziridiny)phosphine sulride (thiotepa)
N-Nitrosopiperidine	Tris(2,3-dibromopropyl)phosphate
N-Nitrosapyrrolidine	Trp-P-1 (Tryptophan-P-1)
N-Nitrososarcosine	Trp-P-2 (Tryptophan-P-2)
Orange Oil SS	Unleaded gasoline
Oxymetholone	Uracil mustard
Panfuran S	Urethane (Ethyl carbamate)
Phenacetin	Vinyl bromide
Phenazopyridine and its hydrochloride	Vinyl chloride
Phenoxybenzamine and its hydrochloride	
Phenytoin and sodium salt	
Polybrominated biphenyls	
Polychlorinated biphenyls (containing 60 or more percent chlorine by molecular weight)	
Ponceau MX	
Ponoeau 3R	
Procarbazine and its hydrochloride	
1,3-Propane sultone	
Propylene oxide	
b-Propiolactone	
Propylthiouracil	
Sodium saccharin	
Safrole	
Silica, crystalline (airborne particles of respirable size)	
Soots, tars, and lubricant base oils and derived products, specifically vacuum distillates, acid treated oils, aromatic oils, mildly solvent-refined oils, mildly hydrotreated oils, and used engine oils; and mineral oils, when used in occupations such as mulespinning, metal machining, and jute processing.	
Sterigmatocystin	
Streptozotocin	
Styrene oxide	
Sulfallate	
Testosterone and its esters	
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)	
Tetrachloroethylene (Perchloroethylene)	
Thioacetamide	
4,4'-Thiodianiline	
Thiourea	
Thorium dioxide	
Tobacco, oral use of smokeless products	
Tobacco smoke	
ortho-Toluidine and its hydrochloride	

# ATTACHMENT M - COMPOUNDS SHOWN IN EPIDEMIOLOGICAL STUDIES TO CAUSE SPONTANEOUS ABORTION OR TERATOLOGY IN HUMANS\*

Subject Matter Expert: [Jenifer Leon](#)

GN470094, Issue C

Revision Date: [August 5, 2003](#), Replaces Document Dated: March 20, 1997

Administrative Changes: November 4, 2004 and [June 29, 2005](#)

Compound Category	Compound Name	Effect(s)
Metals	Lead	Abortion, mental retardation
	Methylmercury	Teratology-nervous system
	Lithium	Teratology-heart defect
	Aluminum	Teratology-nervous system
	Arsenic	Abortion, teratology
Drugs	Diethylstilbestrol	Adenocarcinoma
	Thalidomide	Teratology-limbs
	Antieoplastic drugs	Abortion
	Anesthetics	Abortion
	Alcohol	Fetal alcohol syndrome
	Anticonvulsants	Teratology
	Retinoids	Teratology
	Smoking	Low birth weight
Chemicals	Chlorinated pesticides	Abortion
	Polychlorinated biphenyls	Teratology



	Ethylene oxide	Abortion
	2,4,5,T (dioxin)	Abortion, teratology
Solvents	Benzene Xylene Cyclohexanone Propylene glycol Alkane sulfones Glycol ethers Acetamides Formamides	Teratology, embryotoxic



\*B. S. Shane, *Human Reproductive Hazards*, Environmental Science & Technology, Volume 23, Number 10, 1989, p. 1187. The table is taken directly from this reference. Exposures that produce the effects listed are described in the reference.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT N - CHEMICALS "KNOWN TO THE STATE OF CALIFORNIA TO BE REPRODUCTIVE TOXINS"

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Subject Matter Expert: [Jenifer Leon](#)

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All-trans retinoic acid

Aminopterin

Busulfan

Chlorambucil

Chlorcyclizine hydrochloride

Chlordecone (Kepone [Reg TM])

Cycloheximide

Cyclophosphamide

Cyhexatin

Cytarabine

1,2-Dibromo-3-chloropropane (DBCP)

Diethylstilbestrol (DES)

Dinoceb

Diphenylhydantoin



Ethyl alcohol in alcoholic beverages

Ethylene glycol monoethyl ether

Ethylene glycol monomethyl ether

Ethylene oxide

Etretinate

Fluoroaracil

Hexachlorobenzene

Iodine-131

Isotretinoin



Lead

Mechlorethamine

Methotrexate

Methyl mercury

Thalidomide

Tobacco smoke (not environmental tobacco smoke)

Valproate

Warfarin



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



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# ATTACHMENT O - CHEMICALS OF ACUTE TOXICITY

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Subject Matter Expert: [Jenifer Leon](#)

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<b>CAS Number</b>	<b>Name</b>
107-20-0	Acetaldehyde, chloro-
591-08-2	Acetamide, N-(aminothioxomethyl)-
640-19-7	Acetamide, 2-fluoro-
62-74-8	Acetic acid, fluoro-, sodium salt
591-08-2	1-Acetyl-2-thiourea
107-02-8	Acrolein
116-06-3	Aldicarb
309-00-2	Aldrin
107-18-6	Allyl alcohol
20859-73-8	Aluminum phosphide
2763-96-4	5-(Aminomethyl)-3-isoxazolol
504-24-5	4-Aminopyridine
7803-55-6	Ammonium vanadate
506-61-6	Argentate(1-), bis(cyano-C)-, potassium
7778-39-4	Arsenic acid $H_3AsO_4$
1327-53-3	Arsenic oxide $As_2O_3$
1303-28-2	Arsenic oxide $As_2O_3$
1303-28-2	Arsenic pentoxide

1327-53-3	Arsenic trioxide
692-42-2	Arsine, diethyl-
696-28-6	Arsonous dichloride, phenyl-
151-56-4	Aziridine
75-55-8	Aziridine, 2-methyl-
542-62-1	Barium cyanide
106-47-8	Benzenamine, 4-chloro-
100-01-6	Benzenamine, 4-nitro-
100-44-7	Benzene, (chloromethyl)-
122-09-8	Benzeneethanamine, alpha,alpha-dimethyl-
108-98-5	Benzenethiol
81-81-2†	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts
100-44-7	Benzyl chloride
7440-41-7	Beryllium
598-31-2	Bromoacetone
357-57-3	Brucine
39196-18-4	2-Butanone, 3,3-dimethyl-1 -(methylthio)-, O-[(methylamino) carbonyl] oxime
592-01-8	Calcium cyanide
75-15-0	Carbon disulfide
75-44-5	Carbonic dichloride
107-20-0	Chloroacetaldehyde
106-47-8	p-Chloroaniline
5344-82-1	1-(o-Chlorophenyl)thiourea
542-76-7	3-Chloropropionitrile
544-92-3	Copper cyanide
n/a	Cyanides (soluble cyanide salts), not otherwise specified
460-19-5	Cyanogen
506-77-4	Cyanogen chloride
131-89-5	2-Cyclohexyl-4,6-dinitrophenol
542-88-1	Dichloromethyl ether
696-28-6	Dichlorophenylarsine
60-57-1	Dieldrin
692-42-2	Diethylarsine

311-45-5	Diethyl-p-nitrophenyl phosphate
297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
55-91-4	Diisopropylfluorophosphate (DFP)
309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-,(1 alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
465-73-6	1,4,5,8-Di methanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-,(1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
60-57-1	2,7:3,6-Dimethanonaphth [2,3-b]oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,(1aalpha,2beta,2alpha,3beta,6beta,6alpha,7beta,7alpha)-
72-20-8†	2,7:3,6-Dimethanonaphth[2,3-b]oxirene,3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,(1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7alpha)-, and metabolites
60-51-5	Dimethoate
122-09-8	alpha,alpha-Dimethylphenethylamine
534-52-1†	4,6-Dinitro-o-cresol, & salts
51-28-5	2,4-Dinitrophenol
88-85-7	Dinoseb
152-16-9	Diphosphoramidate octamethyl-
107-49-3	Diphosphoric acid, tetraethyl ester
298-04-4	Disulfoton
541-53-7	Dithiobiuret
115-29-7	Endosulfan
145-73-3	Endothall
72-20-8	Endrin
72-20-8	Endrin & metabolites
51-43-4	Epinephrine
460-19-5	Ethanedinitrile
16752-77-5	Ethanimidothioic acid, N-[[[(methylamino)carbonyl]oxy]-, methyl ester
107-12-0	Ethyl cyanide

151-56-4 Ethyleneimine  
 52-85-7 Famphur  
 7782-41-4 Fluorine  
 640-19-7 Fluoroacetamide  
 62-74-8 Fluoroacetic acid, sodium salt  
 628-86-4 Fulminic acid, mercury(2+) salt  
 76-44-8 Heptachlor  
 757-58-4 Hexaethyl tetraphosphate  
 79-19-6 Hydrazinecarbothioamide  
 60-34-4 Hydrazine, methyl-  
 74-90-8 Hydrocyanic acid  
 74-90-8 Hydrogen cyanide  
 7803-51-2 Hydrogen phosphide  
 465-73-6 Isodrin  
 2763-96-4 3(2H)-Isoxazolone, 5-(aminomethyl)-  
 62-38-4 Mercury, (acetato-O)phenyl-  
 628-86-4 Mercury fulminate  
 62-75-9 Methanamine, N-methyl-N-nitroso-  
 624-83-9 Methane, isocyanato-  
 542-88-1 Methane, oxybis[chloro-  
 75-70-7 Methanethiol, trichloro-  
 115-29-7 6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10-hexacloeo-  
 1,5,5a,6,9,9a-hexahydro-,  
 3-oxide  
 76-44-8 4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-  
 tetrahydro-  
 16752-77-5 Methomyl  
 60-34-4 Methyl hydrazine  
 624-83-9 Methyl isocyanate  
 75-86-5 2-Methylactonitrile  
 298-00-0 Methyl parathion  
 86-88-4 alpha-Naphthylthiourea  
 13463-39-3 Nickel carbonyl  
 557-19-7 Nickel cyanide

54-11-5† Nicotine & salts

10102-43-9 Nitric oxide

100-01-6 p-Nitroaniline

10102-44-0 Nitrogen dioxide

62-75-9 N-Nitrosodimethylamine

4549-40-0 N-Nitrosomethylvinylamine

152-16-9 Octamethylpyrophosphoramidate

20816-12-0 Osmium tetroxide

145-73-3 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid

56-38-2 Parathion

131-89-5 Phenol, 2-cyclohexyl-4,6-dinitro-

51-28-5 Phenol, 2,4-dinitro-

534-52-1† Phenol, 2-methyl-4,6-dinitro-, & salts

88-85-7 Phenol, 2-(1-methylpropyl)-4,6,-dinitro-

62-38-4 Phenylmercury acetate

103-85-5 Phenylthiourea

298-02-2 Phorate

75-44-5 Phosgene

7803-51-2 Phosphine

311-45-5 Phosphoric acid, diethyl 4-nitrophenyl ester

298-04-4 Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester

298-02-2 Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester

60-51-5 Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester

55-91-4 Phosphorofluoridic acid, bis(1-methylethyl) ester

56-38-2 Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester

297-97-2 Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester

52-85-7 Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O, O-dimethylester

298-00 0 Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester

78-00-2 Plumbane, tetraethyl-

51-50-8 Potassium cyanide



06-61-6	Potassium silver cyanide
16-06-3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl] oxime
107-12-0	Propanenitrile
542-76-7	Propanenitrile, 3-chloro-
75-86-5	Propanenitrile, 2-hydroxy-2-methyl-
598-31-2	2-Propanone, 1-bromo-
107-19-7	Propargyl alcohol
107-02-8	2-Propenal
107-18-6	2-Propen-1-ol
75-55-8	1,2-Propylenimine
107-19-7	2-Propyn-1-ol
504-24-5	4-Pyridinamine
54-11-5†	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
12039-52-0	Selenious acid, dithallium(1+) salt
630-10-4	Selenourea
506-64-9	Silver cyanide
26628-22-8	Sodium azide
143-33-9	Sodium cyanide
1314-96-1	Strontium sulfide SrS
157-24-9	Strychnidin-10-one, & salts
357-57-3	Strychnidin-10-one, 2,3-dimethoxy-
57-24-9†	Strychnine & salts
7446-18-6	Sulfuric acid, dithallium(1+) salt
3689-24-5	Tetraethyldithiopyrophosphate
78-00-2	Tetraethyl lead
107-49-3	Tetraethyl pyrophosphate
757-58-4	Tetraphosphoric acid, hexaethyl ester
1314-32-5	Thallic oxide
1314-32-5	Thallium oxide $Tl_2O_3$
12039-52-0	Thallium(I) selenite
7446-18-6	Thallium(I) sulfate

3589-24-5 Thiodiphosphoric acid, tetraethyl ester  
39196-18- Thiofanox  
4  
541-53-7 Thioimidodicarbonic diamide[(H<sub>2</sub>N)C(S)]<sub>2</sub>NH  
108-98-5 Thiophenol  
79-19-6 Thiosemicarbazide  
5344-82-1 Thiourea, (2-chlorophenyl)-  
86-88-4 Thiourea, 1-naphthalenyl-  
103-85-5 Thiourea, phenyl-  
8001-35-2 Toxaphene  
75-70-7 Trichloromethanethiol  
7803-55-6 Vanadic acid, ammonium salt  
1314-62-1 Vanadium oxide V<sub>2</sub>O<sub>5</sub>  
314-62-1 Vanadium pentoxide (V<sub>2</sub>O<sub>5</sub>)  
549-40-0 Vinylamine, N-methyl-N-nitroso-  
81-81-2† Warfarin & salts  
557-21-1 Zinc cyanide  
557-21-1 Zinc cyanide Zn(CN)<sub>2</sub>  
1314-84-7 Zinc phosphide Zn<sub>3</sub>P<sub>2</sub>

† CAS number for parent compound only.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)



# ATTACHMENT P - HAZARDOUS PROPERTIES OF SOME GASES

Subject Matter Expert: [Jenifer Leon](#)

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Gas Name	Hazardous Properties*	Gas Name	Hazardous Properties*
acetylene	F, (C)	1,1-difluoroethylene	F, (T)
allene	F, (C)	dimethylamine	F, C
ammonia	C	dimethylether	F, (T)
argon	-	2,2-dimethylpropane	F
arsine	T, F	ethane	F
boron trichloride	C	ethylacetylene	F, (C)
borontrifluoride	C	ethylamine	F, C
bromomethane	T, (C)	ethyl chloride	F, (T)
bromotrifluoroethylene	F, T, (C)	ethylene	F
bromotrifluoromethane	(T)	ethylene oxide	F, T
1,3 butadiene	F, (T)	ethyl fluoride	F, (T)
butane	F	fluorine	C
1-butene	F	fluoromethane	F, (T)
cis-2-butene	F	fluoroethane	F, T
trans-2-butene	F	Freon	(T)
1-butyne	F, (C)	germane	F, T
carbon dioxide	(T)	halocarbon (halon), chlorodifluoroethane	F, (T)

carbon monoxide	T, F	halocarbon (halon), chlorotrifluoroethylene	F, (T)
carbon tetrafluoride	(T)	halocarbon (halon), difluoroethane	F, (T)
carbonyl fluoride	C	halocarbon (halon), difluoroethylene	F, (T)
carbonyl sulphide	F, T	halocarbon (halon), methyl fluoride	F, (T)
chlorine	C	halocarbon (halon), tetrafluoroethylene	F, (T)
chlorine trifluoride	C	halocarbon (halon), vinyl chloride	F, (T)
1-chloro-1,1-difluoroethane	F, (T)	halocarbon (halon), vinyl fluoride	F, (T)
chlorodifluoromethane	(T)	halocarbon (halon), others	(T)
chloroethane	F, (T)	helium	-
chloromethane	F, C	hexafluoroacetone	T
chloropentafluoroethane	(T)	hexafluoroethane	(T)
2-chloropropene	F, (T)	hexafluoropropene	T
chlorotrifluoroethylene	F, T	hydrogen	F
chlorotrifluoromethane	(T)	hydrogen bromide	C
cyanogen	T, F	hydrogen chloride	C
cyclopropane	F, T	hydrogen cyanide	T, F
deuterium	F	hydrogen fluoride	C
diborane	F, T	hydrogen iodide	C
dibromodifluoromethane	(T)	hydrogen selenide	T, F
dichlorodifluoromethane	(T)	hydrogen sulfide	T, F, (C)
dichlorofluoromethane	(T)	hydrogen telluride	T, F
1,2-dichlorotetrafluoroethane	(T)	iodine pentafluoride	C
difluorodiazine	T	isobutane	F
1,1-difluoroethane	F, (T)	isobutylene	F, (T)
krypton	-	propene	F
MAPP gas	F	propylene	F



methane	F	propylene oxide	T, F
methanethiol	T, F	propyne	F, (C)
methyl acetylene	F, (C)	silane	F, T
methylamine	F, C	silicon tetrachloride	C
methyl bromide	T, (C)	silicon tetrafluoride	C
2-methyl-1-butene	F, (T)	stibine	T, F
2-methyl-2-butene	F, (T)	sulphur dioxide	C
3-methyl-1-butene	F, (T)	sulphur hexafluoride	(T)
methyl chloride	F, C	sulphur tetrafluoride	C
methyl fluoride	F, T	sulphuryl fluoride	T, (C)
methyl mercaptan	T, F	tetrafluoroethylene	F, (T)
2-methylpropane	F	tetrafluorohydrazine	F, T
2-methylpropene	F	town gas	F, T
methyl vinyl ether	F, (T)	trichlorofluoromethane	(T)
natural gas	F	trifluoroiodomethane	T
neon	-	trifluoromethyl iodide	T
nitric oxide	C	trifluoromethane	(T)
nitrogen	-	trimethylamine	F, (T), (C)
nitrogen dioxide	C	tungstenhexafluoride	T
nitrogen trifluoride	C, I	vinyl bromide	F, (T), (C)
nitrogen trioxide	C	vinyl chloride	F, T, (C)
nitrosyl chloride	C	vinyl fluoride	F, (T), (C)
nitrous oxide	(T)	vinyl methyl ether	F, (T)
octafluoro-2-butene	(T)	xenon	-
octafluorocyclobutane	(T)	<p>*  <b>Legend:</b>  C - corrosive  (C) - corrosive to a few materials  F - flammable  T - toxic</p>	
octafluoropropane	(T)		
oxygen	-		
ozone	T, C		
perfluoro-2-butene	T		
perfluoropropane	(T)		
phosgene	T, C		
phosphine	T, F		

phosphorus pentafluoride	C	(T) - toxic in larger amounts
propane	F	

Extracted from: Martin J. Pitt and E. Pitt, *Handbook of Laboratory Waste Disposal*, Ellis Horwood, Ltd., 1985.



[Jenifer Leon, jaleon@sandia.gov](mailto:jaleon@sandia.gov)

[Bob Goetsch, rsgoets@sandia.gov](mailto:rsgoets@sandia.gov)

