

Particularly Hazardous Substances Definitions

Particularly hazardous substances fall into the following three major categories: acute toxins, reproductive toxins, and carcinogens.

Acute Toxins

Substances that have a high degree of acute toxicity are substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. They can be defined as:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each;
2. A chemical with a median lethal dose (LD50) of 200 mg or less per 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 2 and 3 Kg each; and
3. A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). A list of reproductive toxins is maintained online at http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html#files.

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period.

The term "regulated carcinogen" means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. See *Attachment A for the specific list of Regulated Carcinogens*.

The term "Listed Carcinogen" refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. See *Attachment B for the specific list of Listed Carcinogens*.

The term "select carcinogen" refers to a category of chemicals where the available evidence strongly indicates that the substances cause human carcinogenicity. A select carcinogen meets one of the following criteria:

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

ATTACHMENT A

Regulated Carcinogens

The term "regulated carcinogen" means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. For more information, see UCLA Policy 907.

- Acrylonitrile
- Arsenic metal and inorganic arsenic compounds
- Asbestos
- Benzene
- 1,3-butadiene
- Cadmium metal and cadmium compounds
- Chromium(VI) compounds
- Coke Oven Emissions
- 1,2-Dibromo-3-chloropropane (DBCP)
- Ethylene Dibromide (EDB)
- Ethylene Oxide (EtO)
- Formaldehyde gas and formaldehyde solutions
- Lead metal and inorganic lead compounds
- Methylene Chloride
- 4,4'-Methylene bis(2-chloroaniline) (MBOCA)
- Methylenedianiline (MDA)
- Vinyl Chloride
- 2-Acetylaminofluorene
- 4-Aminodiphenyl
- Benzidine (and its salts)
- 3,3'-Dichlorobenzidine (and its salts)
- 4-Dimethylaminoazobenzene
- alpha-Naphthylamine
- beta-Naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- Methyl chloromethyl ether
- Ethyleneimine

ATTACHMENT B

Listed Carcinogens

The term "listed carcinogen" refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. For more information, see UCLA Policy 907.

- 2-Acetylaminofluorene
- 4-Aminodiphenyl
- Benzidine (and its salts)
- 3,3'-Dichlorobenzidine (and its salts)
- 4-Dimethylaminoazobenzene
- alpha-Naphthylamine
- beta-Naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- Methyl chloromethyl ether
- Ethyleneimine

Table 1 - Poisonous Gases

The gases on this list are either on the Department of Transportation's Category 1 list, or the Linde Specialty Gases company's Group 6 - Very Poisonous list. These chemicals are highly toxic gases at ambient temperature and pressure. They have an extremely high potential for causing significant harm if not adequately controlled.

- Arsine
- Boron trichloride
- Chlorine pentafluoride
- Chlorine trifluoride
- Cyanogen
- Cyanogen chloride
- Diborane
- Dinitrogen tetroxide
- Fluorine
- Germane
- Hydrogen selenide
- Nickel Carbonyl
- Nitric oxide
- Nitrogen dioxide
- Nitrogen trioxide
- Nitrosyl chloride
- Oxygen difluoride
- Phosgene
- Phosphine
- Phosphorus pentafluoride
- Selenium hexafluoride
- Stibine
- Sulfur tetrafluoride
- Tellurium Hexafluoride
- Tetraethyldithiopyrophosphate
- Tetraethylpyrophosphate

Table 2 - Pyrophoric Chemicals

The classes of chemicals listed below will readily oxidize and ignite spontaneously in air. Therefore, users must demonstrate to the department and EH&S that they have the appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

- Grignard reagents, RMgX
- Metal alkyls and aryls, such as RLi, RNa, R₃Al, R₂Zn
- Metal carbonyls such as Ni(CO)₄, Fe(CO)₅, Co₂(CO)₈
- Alkali metals such as Na, K

Examples of PHS from various hazard categories

- Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
- Metal hydrides such as NaH, LiAlH₄
- Nonmetal hydrides, such as B₂H₆ and other boranes, PH₃, AsH₃
- Nonmetal alkyls, such as R₃B, R₃P, R₃As
- Phosphorus (white)

Table 3 - Shock Sensitive Chemicals

The classes of chemicals listed below may explode when subjected to shock or friction. Therefore users must have appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

- Acetylenic compounds, especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)
- Acyl nitrates
- Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine
- Alkyl and acyl nitrites
- Alkyl perchlorates
- Amminemetal oxosalts: metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group
- Azides, including metal, nonmetal, and organic azides
- Chlorite salts of metals, such as AgClO_2 and $\text{Hg}(\text{ClO}_2)_2$
- Diazo compounds such as CH_2N_2
- Diazonium salts, when dry
- Fulminates such as mercury fulminate ($\text{Hg}(\text{CNO})_2$)
- Hydrogen peroxide (which becomes increasingly treacherous as the concentration rises above 0%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals)
- N-Halogen compounds such as difluoroamino compounds and halogen azides
- N-Nitro compounds such as N-nitromethylamine, nitrourea, nitroguanidine, and nitric amide
- Oxo salts of nitrogenous bases: perchlorates, dichromates, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.
- Perchlorate salts (which can form when perchloric acid mists dry in fume hoods or associated duct work. Most metal, nonmetal, and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials)
- Peroxides and hydroperoxides, organic
- Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents (see the following Section 3)
- Peroxides, transition-metal salts
- Picrates, especially salts of transition and heavy metals, such as Ni, Pb, Hg, Cu, and Zn
- Polynitroalkyl compounds such as tetranitromethane and dinitroacetonitrile

Examples of PHS from various hazard categories

- Polynitroaromatic compounds especially polynitrohydrocarbons, phenols, and amines (e.g., dinitrotoluene, trinitrotoluene, and picric acid)

Note: Perchloric acid must be used only in specially-designed perchloric acid fume hoods that have built-in wash down systems to remove shock-sensitive deposits. Before purchasing this acid, laboratory supervisors must arrange for use of an approved perchloric acid hood.

Table 4 - Peroxide-Forming Chemicals

The chemicals listed below can form explosive peroxide crystals on exposure to air, and therefore require special handling procedures after the container is opened. Some of the chemicals form peroxides that are violently explosive in concentrated solution or as solids, and therefore should never be evaporated to dryness. Others are polymerizable unsaturated compounds and can initiate a runaway, explosive polymerization reaction. All peroxidizable compounds should be stored away from heat and light. They should be protected from physical damage and ignition sources. A warning label should be affixed to all peroxidizable materials to indicate the date of receipt and the date the container was first opened. Due to these special handling requirements, users must have the appropriate laboratory equipment, information, knowledge and training to use these compounds safely.

Severe Peroxide Hazard with Exposure to Air

(discard within 3 months from opening)

- diisopropyl ether (isopropyl ether)
- divinylacetylene (DVA)
- vinylidene chloride (1,1-dichloroethylene)
- potassium metal
- sodium amide (sodamide)
- potassium amide

Peroxide Hazard on Concentration

Do not distill or evaporate without first testing for the presence of peroxides
(discard or test for peroxides after 6 months)

- acetaldehyde diethyl acetal (acetal)
- cumene (isopropylbenzene)
- cyclohexene
- cyclopentene
- decalin (decahydronaphthalene)
- diacetylene (butadiene)
- dicyclopentadiene
- diethyl ether (ether)
- diethylene glycol dimethyl ether (diglyme)
- dioxane
- ethylene glycol dimethyl ether (glyme)
- ethylene glycol ether acetates
- ethylene glycol monoethers (cellosolves)
- furan
- methylacetylene
- methylcyclopentane
- methyl isobutyl ketone
- tetrahydrofuran (THF)
- tetralin (tetrahydronaphthalene)
- vinyl ethers

Hazard of Rapid Polymerization Initiated by Internally-Formed Peroxides

Liquids (dispose of or test for peroxides after 6 months)

- chloroprene (2-chloro-1,3-butadiene)

Examples of PHS from various hazard categories

- vinyl acetate
- styrene
- vinylpyridine

Gases (dispose of after 12 months)

- butadiene
- vinylacetylene (MVA)
- tetrafluoroethylene (TFE)
- vinyl chloride

Example Shelf Life of Unstable Chemical

Peroxide Hazard on Storage Discard After Three (3) Months

Isopropyl ether	Divinyl acetylene
Vinylidene chloride	Potassium metal
Sodium amide	

Peroxide Hazard on Concentration Discard After One (1) Year

Ethyl ether	Tetrahydrofuran
Dioxane	Acetal
Methyl isobutyl ketone (glyme)	Ethylene glycol dimethyl ether
Vinyl ethers	Dicyclopentadiene
Diacetylene	Metal acetylene
Cumene	Tetrahydronaphthalene
Cyclohexane	t-Butyl alcohol

Hazardous to Peroxide Initiation of Polymerization Discard After One (1) Year

Styrene	Butadiene
Tetrafluoroethylene	Chlorotrifluoroethylene
Vinyl acetylene	Vinyl acetate
Vinyl chloride	Vinyl pyridine
Chlorobutadiene (Chloroprene)	9,10-Dihydroanthracene
Indene	Dibenzocyclopentadiene

Table 5 Carcinogens, Reproductive Toxins & Highly Toxic Chemicals

The chemicals listed below are extremely hazardous. Workers must demonstrate knowledge of the dangers of these chemicals prior to use, and document training in safe working procedures. Please review the Particularly Hazardous Materials (PHM) list from EH&S for more carcinogenic and reproductive hazards.

Biologically active compounds

- protease inhibitors (e.g. PMSF, Aprotin, Pepstatin A, Leupeptin);
- protein synthesis inhibitors (e.g. cycloheximide, Puromycin);
- transcriptional inhibitors (e.g. α -amanitin and actinomycin D);
- DNA synthesis inhibitors (e.g. hydroxyurea, nucleotide analogs (i.e. dideoxy nucleotides), actinomycin D, acidicolin);
- phosphatase inhibitors (e.g. okadaic acid);
- respiratory chain inhibitors (e.g. sodium azide);
- kinase inhibitors (e.g. NaF);
- mitogenic inhibitors (e.g. colcemid); and
- mitogenic compounds (e.g. concanavalin A).
- Castor bean (*Ricinus communis*) lectin: Ricin A, Ricin B, RCA toxins
- Diisopropyl fluorophosphate: highly toxic cholinesterase inhibitor; the antidote, atropine sulfate and 2-PAM (2-pyridinealdoxime methiodide) must be readily available
- Jaquiritry bean lectin (*Abrus precatorius*)
- N-methyl-N'-nitro-N-nitrosoguanidine: carcinogen (this chemical forms explosive compounds upon degradation)
- Phalloidin from *Amanita* Phalloides: used for staining actin filaments
- Retinoids: potential human teratogens
- Streptozotocin: potential human carcinogen
- Urethane (ethyl carbamate): an anesthetic agent, potent carcinogen and strong teratogen, volatile at room temperature

**Cal-OSHA Regulated Carcinogens -
A Select list Common to Research Laboratories**

(If using these chemicals, contact EH&S regarding Carcinogen Requirements)

CAS #	Carcinogen Name	Exposure Limit
53-96-3	2-Acetylaminofluorene	[1910.1014]
107-13-1	Acrylonitrile [1910.1045]	2 ppm PEL {4.3 mg/m ³ }
77536-66-4	Actinolite [asbestiform]	0.1 f/cc PEL
92-67-1	4-Aminobiphenyl	[1910.1011]
92-67-1	4-Aminodiphenyl	[1910.1011]
12172-73-5	Amosite	0.1 f/cc PEL
77536-67-5	Anthophyllite [asbestiform]	0.1 f/cc PEL
10102-53-1	m-Arsenic Acid	10 µg/m ³ PEL
7778-39-4	o-Arsenic Acid	10 µg/m ³ PEL
7774-41-6	Arsenic Acid Hemihydrate	10 µg/m ³ PEL
1303-32-8	Arsenic Disulfide	10 µg/m ³ PEL
7440-38-2	Arsenic, Inorganic [1910.1018] specific compound]	10 µg/m ³ PEL
1303-28-2	Arsenic Pentoxide	10 µg/m ³ PEL
7784-33-0	Arsenic Tribromide	10 µg/m ³ PEL
7784-34-1	Arsenic Trichloride	10 µg/m ³ PEL
7784-35-2	Arsenic Trifluoride	10 µg/m ³ PEL
7784-45-4	Arsenic Triiodide	10 µg/m ³ PEL
1327-53-3	Arsenic Trioxide	10 µg/m ³ PEL
1303-36-2	Arsenic Triselenide	10 µg/m ³ PEL
1303-33-9	Arsenic Trisulfide	10 µg/m ³ PEL
8024-75-9	Arsenical Dip	10 µg/m ³ PEL
14060-38-9	Arsenious Acid	10 µg/m ³ PEL
1332-21-4	Asbestos	0.1 f/cc PEL
71-43-2	Benzene [1910.1028]	0.5 ppm TLVH {1.6 mg/m ³ }
1684-47-5	Benzene-1,3,5-d ₃ {C ₆ H ₃ D ₃ }	0.5 ppm TLVH {1.6 mg/m ³ }
1120-89-4	Benzene-d {C ₆ H ₅ D ₁ }	0.5 ppm TLVH {1.6 mg/m ³ }
1076-43-3	Benzene-d ₆ {C ₆ D ₆ }	0.5 ppm TLVH {1.6 mg/m ³ }
92-87-5	Benzidine	[1910.1010]
106-99-0	1,3-Butadiene [1910.1051]	1 ppm PEL {2.2 mg/m ³ }
7440-43-9	Cadmium & Cd compounds, as Cd [1910.1027] - [see specific compound]	5 µg/m ³ PEL {2 µg/m ³ respirable}

Examples of PHS from various hazard categories

CAS #	Carcinogen Name	Exposure Limit
543-90-8	Cadmium Acetate	5 µg/m ³ PEL {2 µg/m ³ respirable}
7789-42-6	Cadmium Bromide	5 µg/m ³ PEL {2 µg/m ³ respirable}
513-78-0	Cadmium Carbonate	5 µg/m ³ PEL {2 µg/m ³ respirable}
10108-64-2	Cadmium Chloride	5 µg/m ³ PEL {2 µg/m ³ respirable}
542-83-6	Cadmium Cyanide	5 µg/m ³ PEL {2 µg/m ³ respirable}
7790-79-6	Cadmium Fluoride	5 µg/m ³ PEL {2 µg/m ³ respirable}
21041-95-2	Cadmium Hydroxide	5 µg/m ³ PEL {2 µg/m ³ respirable}
7790-80-9	Cadmium Iodide	5 µg/m ³ PEL {2 µg/m ³ respirable}
10325-94-7	Cadmium Nitrate	5 µg/m ³ PEL {2 µg/m ³ respirable}
1306-19-0	Cadmium Oxide	5 µg/m ³ PEL {2 µg/m ³ respirable}
0-41-0	Cadmium Oxide Production	5 µg/m ³ PEL {2 µg/m ³ respirable}
14402-75-6	Cadmium Potassium Cyanide	5 µg/m ³ PEL {2 µg/m ³ respirable}
13814-62-5	Cadmium Selenate	5 µg/m ³ PEL {2 µg/m ³ respirable}
1306-24-7	Cadmium Selenide	5 µg/m ³ PEL {2 µg/m ³ respirable}
2223-93-0	Cadmium Stearate	5 µg/m ³ PEL {2 µg/m ³ respirable}
10124-36-4	Cadmium Sulfate	5 µg/m ³ PEL {2 µg/m ³ respirable}
1306-23-6	Cadmium Sulfide	5 µg/m ³ PEL {2 µg/m ³ respirable}
1306-25-8	Cadmium Telluride	5 µg/m ³ PEL {2 µg/m ³ respirable}
7790-85-4	Cadmium Tungstate (VI)	5 µg/m ³ PEL {2 µg/m ³ respirable}
12685-29-9	Cadmium-Copper Alloy, cadmium nonbase	5 µg/m ³ PEL {2 µg/m ³ respirable}

Examples of PHS from various hazard categories

CAS #	Carcinogen Name	Exposure Limit
37364-06-0	Cadmium-Copper Alloy, copper base	5 µg/m ³ PEL {2 µg/m ³ respirable}
132295-56-8	Cadmium-Copper Alloy, copper alloy, base, Cu>99.75%	5 µg/m ³ PEL {2 µg/m ³ respirable}
132295-57-9	Cadmium-Copper Alloy, copper alloy, base, Cu>99.60%	5 µg/m ³ PEL {2 µg/m ³ respirable}
7778-44-1	Calcium Arsenate	10 µg/m ³ PEL
10103-62-5	Calcium Arsenate	10 µg/m ³ PEL
52740-16-6	Calcium Arsenite, 1:1	10 µg/m ³ PEL
15194-98-6	Calcium Arsenite, 2:1	10 µg/m ³ PEL
27152-57-4	Calcium Arsenite, 2:3	10 µg/m ³ PEL
75-01-4	Chloroethylene [1910.1017]	1 ppm PEL
542-88-1	bis(Chloromethyl)ether	[1910.1008] {1 ppb TLV, 4.7 µg/m ³ }
107-30-2	Chloromethylmethylether	[1910.1006]
12001-29-5	Chrysotile	0.1 f/cc PEL
7785-24-2	Cobalt (II) Arsenate	10 µg/m ³ PEL
0-07-0	Coke oven emissions [i.e., PAHs]	150 µg/m ³ PEL
12002-03-8	Copper (II) Acetoarsenite	10 µg/m ³ PEL
12001-28-4	Crocidolite	0.1 f/cc PEL
12002-03-8	Cupric Acetoarsenite	10 µg/m ³ PEL
10290-12-7	Cupric Arsenite	10 µg/m ³ PEL
96-12-8	1,2-Dibromo-3-chloropropane [1910.1044]	1 ppb PEL
91-94-1	3,3'-Dichlorobenzidine	[1910.1007]
60-11-7	4-Dimethylaminoazobenzene	[1910.1015]
60-11-7	p-Dimethylaminoazobenzene	[1910.1015]
62-75-9	N,N-Dimethylnitrosoamine	[1910.1016]
7778-43-0	Disodium Arsenate	10 µg/m ³ PEL
10048-95-0	Disodium Arsenate Heptahydrate	10 µg/m ³ PEL
10048-95-0	Disodium Hydrogen Arsenate	10 µg/m ³ PEL
8012-54-2	Donovan's Solution, as As ³⁺	10 µg/m ³ PEL
75-21-8	Ethylene Oxide [1910.1047]	1 ppm PEL {1.8 mg/m ³ }
151-56-4	Ethyleneimine	[1910.1012] {0.5 ppm TLV, 0.88 mg/m ³ }
50-00-0	Formaldehyde [1910.1048]	C 0.3 ppm TLV {C 0.37 mg/m ³ }
1327-53-3	Fowler's Solution, as As ³⁺	10 µg/m ³ PEL

Examples of PHS from various hazard categories

CAS #	Carcinogen Name	Exposure Limit
1303-00-0	Gallium Arsenide	10 µg/m ³ PEL
7440-38-2	Inorganic Arsenic [1910.1018] - [see specific compound]	10 µg/m ³ PEL
3687-31-8	Lead Arsenate, as As ³⁺	10 µg/m ³ PEL
7645-25-2	Lead Arsenate, as As ³⁺	10 µg/m ³ PEL
7784-40-9	Lead Arsenate, as As ³⁺	10 µg/m ³ PEL
10102-48-4	Lead Arsenate, as As ³⁺	10 µg/m ³ PEL
10031-13-7	Lead Arsenite, as As ³⁺	10 µg/m ³ PEL
10103-50-1	Magnesium Arsenate	10 µg/m ³ PEL
107-30-2	Methylchloromethylether	[1910.1006]
101-77-9	4,4'-Methylenedianiline [1910.1050]	10 ppb PEL {0.081 mg/m ³ }
107-30-2	Monochlorodimethylether	[1910.1006]
91-59-8	2-Naphthylamine	[1910.1009]
134-32-7	alpha-Naphthylamine	[1910.1004]
91-59-8	beta-Naphthylamine	[1910.1009]
92-93-3	4-Nitrobiphenyl	[1910.1003]
92-93-3	4-Nitrodiphenyl	[1910.1003]
62-75-9	N-Nitrosodimethylamine	[1910.1016]
30525-89-4	Paraformaldehyde	C 0.3 ppm TLV {C 0.37 mg/m ³ }
7784-41-0	Potassium Arsenate	10 µg/m ³ PEL
13464-35-2	Potassium Arsenite	10 µg/m ³ PEL
57-57-8	beta-Propiolactone	[1910.1013] {0.5 ppm TLV, 1.5 mg/m ³ }
7631-89-2	Sodium Arsenate	10 µg/m ³ PEL
15120-17-9	Sodium Arsenate	10 µg/m ³ PEL
7784-46-5	Sodium Arsenite	10 µg/m ³ PEL
14807-96-6	Talc (containing asbestos fibers)	0.1 f/cc PEL
14567-73-8	Tremolite [asbestiform]	0.1 f/cc PEL
64070-83-3	Trisodium Arsenate Heptahydrate	10 µg/m ³ PEL
75-01-4	Vinyl Chloride [1910.1017]	1 ppm PEL
107-13-1	Vinyl Cyanide [1910.1045]	2 ppm PEL {4.3 mg/m ³ }