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UNDERSTANDING TOXICITY*

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The word "Toxic" has become the scare word of the eighties. Recently a machinist asked his supervisor if it was safe to touch brass. The machinist had read the MSDS (Attachment A) provided by the supplier which contains the following phrases:

Loss of consciousness/death from welding gases or loss of Oxygen

Neurological damage

Bronchial asthma, lung fibrosis, pneumoconiosis

Suspected carcinogen (reference to Nickel)

Compulsive behavior, mask-like face, Parkinson-like syndrome (Manganese)

Why are these words contained in an MSDS for a material with which humans have been in intimate contact for thousands of years and why does an intelligent worker who has worked with this material most of his life become fearful after reading the MSDS? Each of us is exposed to this toxic material every day. The faucets in our home and the pipes that bring the water to the faucet are made of copper and brass as are the coins in our pocket. The water from the faucet contains soluble copper; animal and vegetable materials that we consume, the earth we live on and our bodies themselves contain copper. Clearly, copper saturates our bodies and our lives and still we survive. Clearly, there are factors at work that the MSDS did not sufficiently explain.

A means to convey some understanding of toxicity is needed. An overall approach consists of four elements:

1. The Quiz - You just think you know something about toxicity.
2. The MSDS - Why it says those frightening things.
3. The Saturation of Your World with Toxics - You breathe them, drink them, eat them, are surrounded by them, and are composed of them.
4. You Survive - the concept of dose and exposure.

Each element is intended to challenge preconceptions, then build toward an overall understanding. The elements are explained as follows and are supported by the attachments.

The Quiz

Each participant is given a list of common materials and asked to assign each material a numerical value ranging from 1 (almost non-toxic) to 6 (supertoxic) (Attachment B). After completing this task, the correct values are revealed (Attachment C) and the participants are generally surprised to discover how badly wrong they were. The point of the exercise is to challenge the audience's perception of what is truly toxic and to bring home the concept that both they and their associates consume clinically toxic materials routinely and yet they are still living - how can it be?

The Material Safety Data Sheet

The Federal Occupational Safety and Health Act Section 1910.1200, commonly called the "Hazard Communication Standard" requires manufacturers and importers of hazardous materials to provide an MSDS to the consumer. It further requires them to produce the MSDS after considering the "available scientific evidence concerning such hazards. For health hazards, evidence which is statistically significant and which is based on at least one positive study...is considered to be sufficient to establish a hazardous effect...". Further, "If a mixture has not been tested as a whole (almost none have been) to determine whether the mixture is a health hazard, the mixture shall be assumed to present the same health hazard as do the components which comprise 1% or greater of the mixture, except that the mixture shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1% or greater which is considered to be a carcinogen...". Additionally, even if a component comprises less than 1% or 0.1% of a carcinogen but could conceivably be released in a concentration that exceeds OSHA standards, the mixture "shall be assumed to present the same hazard".

When queried, toxicologists, epidemiologists, industrial hygienists, and other safety professionals universally state that "everything is toxic at some dose". Many manufacturers faced with the task of generating an MSDS for their products which contain materials shown in "at least one study" to be harmful and in the absence of any knowledge of how the product will be used and, consequently, what exposures may result, opt to provide themselves maximum protection by revealing all. This approach insures some protection against suits alleging "failure to warn". It can also lead to the labeling of substances as hazardous when they could only be construed as such under the most bizarre circumstance. Whiteout contains TCA, an OSHA regulated material that can cause headache, central nervous system depression, poor equilibrium, cardiac arrhythmia and death. Millions of 1 ounce bottles are used every year without harm but the prudent manufacturer who has no control over the use of his product will indicate on the MSDS the known effects even though an exposure sufficient to cause the effect is essentially not possible.

The Saturation of Your World With Toxics

This part of the presentation was designed to demonstrate via visual materials that toxics are in the air we breathe (Attachment D), the water we drink (Attachments E & F), the earth upon which we live (Attachment G), the foods we eat (Attachment H & J), the plants we surround ourselves with (Attachment K), the products we use in our homes and shops (Attachment L & M) and our bodies themselves (Attachment I). The attachments are self-explanatory and the presentation simply consists of exposing the audience to the information and answering questions.

You Survive

Having established that we live every hour of our lives awash in a sea of toxic materials, the focus of our inquisitiveness becomes - how is it that we survive? Simply stated, we survive because there must be exposure and a sufficiently large dose to be harmful before injury to health occurs. Exposure occurs when a material enters the body typically by inhalation, absorption, and ingestion.

Exposure - the dieffenbachia in your living room at home causes no harm because you do not eat it. The lead plates in the battery in your car cause no harm as you drive. In both cases, there is no exposure. Exposure occurs when a material is mixed with the air you breathe then inhaled. Some materials pass directly through the skin. Other materials are unintentionally ingested such as when a worker has been handling lead then fails to wash his hands before handling the sandwich that is lunch.

1. Inhalation. The most common type of exposure occurs when you breathe a substance into the lungs. The lungs consist of branching airways (called bronchi) with clusters of tiny air sacs (called alveoli) at the ends of the airways. The alveoli absorb oxygen and other chemicals into the bloodstream.

   Some chemicals are irritants and cause nose or throat irritation. They may also cause discomfort, coughing, or chest pain when they are inhaled and come into contact with the bronchi (chemical bronchitis). Other chemicals may be inhaled without causing such warning symptoms, but they still can be dangerous.

   Sometimes a chemical is present in the air as small particles (dust or mist). Some of these particles, depending on their size, may be deposited in the bronchi and/or alveoli. Many of them may be coughed out, but others may stay in the lungs and may cause lung damage. Some particles may dissolve and be absorbed into the blood stream, and have effects elsewhere in the body.

2. Skin Contact. The skin is a protective barrier that helps keep foreign chemicals out of the body. However, some chemicals can easily pass through the skin and enter the bloodstream. If the skin is cut or cracked, chemicals can penetrate through the skin more easily. Also, some caustic substances, like strong acids and alkalis, can chemically burn the skin. Others can irritate the skin. Many chemicals, particularly organic solvents, dissolve the oils in the skin, leaving it dry, cracked, and susceptible to infection and absorption of chemicals.

3. Ingestion. The least common source of exposure in the workplace is swallowing chemicals. Chemicals can be ingested if they are left on hands, clothing or beard, or accidentally contaminate food, drinks or cigarettes. Chemicals present in the workplace as dust, for example, metal dusts such as lead or cadmium, are easily ingested.

Dose - In general, the greater the amount of a substance that enters your body, the greater is the effect on your body. This connection between amount and effect is called the *dose-response relationship.*

For example, organic solvents such as toluene, acetone, and trichloroethylene all affect the brain in the same way, but to different degrees at different doses. The effects of these solvents are similar to those which result from drinking alcoholic beverages. At a low dose, you may feel nothing or a mild, sometimes pleasant ("high") sensation. A larger dose may cause dizziness or headache. With an even larger dose you may become drunk, pass out, or even stop breathing.

When you inhale a toxic chemical, the dose you receive depends on four factors: (1) the level (concentration) of chemical in the air; (2) how hard (fast and deep) you are breathing, which depends on your degree of physical exertion; (3) how much of the chemical that is inhaled stays in your lungs and is absorbed into your bloodstream; and (4) how long the exposure lasts.

It is safest to keep exposure to any toxic substance as low as possible. Since some chemicals are much more toxic than others, it is necessary to keep exposure to some substances lower than others. The threshold level is the lowest concentration that might produce a harmful effect. It is different for every chemical. If the concentration of a chemical in the air is kept well below the threshold level, harmful effects probably will not occur. Levels above the threshold are "too much". However, this means only that there is a possibility that health effects might occur, not that such effects definitely will occur.

The body has several systems, most importantly the liver, kidneys and lungs, that change chemicals to a less toxic form (detoxify) and eliminate them. If your rate of exposure to a chemical exceeds the rate at which you can eliminate it, some of the chemical will accumulate in your body. For example, if you work with a chemical for eight hours each day, you have the rest of the day (16 hours) to eliminate it from your body before you are exposed again the next day. If your body can't eliminate all the chemical in 16 hours and you continue to be exposed, the amount in the body will accumulate each day you are exposed. Illness that affects the organs for detoxification and elimination, such as hepatitis (inflammation of the liver), can also decrease their ability to eliminate chemicals from the body.

Accumulation does not continue indefinitely. There is a point where the amount in the body reaches a maximum and remains the same as long as your exposure remains the same. This point will be different for each chemical. Some chemicals, such as ammonia and formaldehyde, leave the body quickly and do not accumulate at all. Other chemicals are stored in the body for long periods. For instance, lead is stored in the bone, calcium is stored in the liver and kidneys, and polychlorinated biphenyls (PCBs) are stored in the fat.

Why then do you survive the many toxics that surround you every day? In many cases there is no exposure - you do not inhale, absorb, or ingest them. In most cases, it is because the doses are very low and your body's detoxification and elimination systems purge them. And what about the MSDS with the horror phrases? It describes the toxic **POTENTIAL** of the material described without describing the hazard presented. Toxic and hazardous are not interchangeable words.

The hazard of a chemical is the practical **LIKELIHOOD** that the chemical will cause harm. To determine the hazard present you must consider the toxicity of the material (1-6), route of exposure and controls present, dose, and duration of exposure. By controlling these factors, Safety Professionals are able to protect workers in the work environment. Hopefully, knowledge gained in the work environment can be applied at home where workers are exposed to a myriad of toxic materials often without the protections provided in the workplace.

Bibliography

1. Item A - Available from Manufacturers Listed
2. Item B & C - Clinical Toxicology of Commercial Products; Gosselin, Smith & Hodge; 5th Edition
3. Item D - Bay Area Air Quality Management District - Air Quality Handbook 1987-1988, BAAQMD Phone # (415) 771-6000
4. Item E & F - Survey of Contemporary Toxicology; Anthony T. Tu; Vol. 1
5. Item G, H, & I - Environment & Health; Norman M. Trieff
6. Item J - American Industrial Hygiene Association Journal, April '88, Cox & Strickland
7. Item K - National Safety Council, Phone # (312) 527-4800
8. Item L & M - Family Safety & Health, Spring '88, Publication of National Safety Council

Text was generously borrowed from many Cal/OSHA publications.

A

Castle Metals®

A. M. CASTLE & CO.
3400 N. Wolf Road
Franklin Park, IL 60131

MSDS FOR COPPER/TWO MANUFACTURERS

Short term exposure to fumes/dust may produce irritation of eyes and respiratory system. Inhalation of high concentrations of freshly formed oxide fumes of copper and lead may cause metal fume fever characterized by a metallic taste in the mouth and irritation of the throat and influenza-like symptoms.

Inhalation or ingestion of lead particles may result in lead-induced systemic toxicity. Symptoms of lead poisoning include abdominal cramps, anemia, muscle weakness and headache. Prolonged exposure can cause behavioral changes, kidney damage, CNS damage and reproductive effects.

Coulter Steel & Forge Company
P.O. Box 8008, 1494 - 67th Street
Emeryville, California 94662-0901
(415) 653-2512 or (800) 648-4884
Copper-base alloys

SECTION V — HEALTH HAZARD INFORMATION

PRIMARY ROUTES OF ENTRY: Inhalation, skin contact
SHORT-TERM EXPOSURE: Metallic taste; nausea; tightness of chest; fever; irritation of eyes, nose, throat, and skin; loss of consciousness/death from welding gases or lack of oxygen
LONG-TERM EXPOSURE: Adverse effects may result from long-term exposure to welding fumes, gases, or dusts. These effects may include skin sensitization, neurological damage, and respiratory disease such as bronchial asthma, lung fibrosis, or pneumoconiosis. Aggravation of preexisting respiratory or allergic conditions may occur in some workers. Nickel has been determined by the IARC to be a suspected carcinogen. Manganese can cause compulsive behavior, a mask-like face, and a Parkinson-like syndrome.
EMERGENCY AND FIRST AID: Remove victim from exposure and obtain prompt medical attention. If victim is unconscious, administer oxygen. If not breathing, resuscitate immediately.

SALICYLATE	ASPIRIN
SACCHARIN	SWEETNER
SOAPS	DETERGENTS
TETRACYCLINES	ORAL/ACNE
PENICILLIN	ORAL/BACTERIAL INFECTION
COCAINE	STREET DRUG
CAFFEINE	COFFEE
HEROINE	STREET DRUG
CODEINE	COUGH MEDICINE
ETHYL ALCOHOL	BOOZE
BENZOYL PEROXIDE	TOPICAL ACNE/CLEARASIL
CALAMINE	POISON IVY/TOPICAL
GASOLINE	YOUR CAR
DIESEL OIL	YOUR TRUCK
PCB	TRANSFORMER FLUID
DDT	PESTICIDE
1,1,1, TRICHLOROETHANE	SOLVENT
DIOXIN	TIMES BEACH
TOBACCO	SNUFF/CIGARETTES
NICOTINE	CIGARETTES

Table II-1
Numerical Toxicity Rating Definitions

Toxicity Rating or Class	Probable Oral LETHAL Dose (Human)	
	Dose	For 70 kg. person (150 lb.)
6 Supertoxic	Less than 5 mg./kg.	A taste (less than 7 drops)
5 Extremely toxic	5–50 mg./kg.	Between 7 drops and 1 teaspoonful (tsp.)
4 Very toxic	50–500 mg./kg.	Between 1 tsp. and 1 ounce
3 Moderately toxic	0.5–5 gm./kg.	Between 1 oz. and 1 pint (or 1 lb.)
2 Slightly toxic	5–15 gm./kg.	Between 1 pt. and 1 quart
1 Practically nontoxic	Above 15 gm./kg.	More than 1 quart (2.2 lb.)

C

4	SALICYLATE	ASPIRIN
2	SACCHARIN	SWEETNER
2	SOAPS	DETERGENTS
2.5	TETRACYCLINES	ORAL ACNE
2.5	PENICILLIN	ORAL BACTERIAL INFECTION
5	COCAINE	STREET DRUG
4	CAFFEINE	COFFEE
6	HEROIN	STREET DRUG
5	CODEINE	COUGH MEDICINE
2.5	ETHYL ALCOHOL	BOOZE
3	BENZOYL PEROXIDE	TOPICAL ACNE/CLEARASIL
2	CALAMINE	POISON IVY/TOPICAL
3	GASOLINE	YOUR CAR
3	DIESEL OIL	YOUR TRUCK
3	PCB	TRANSFORMER FLUID
4	DDT	PESTICIDE
3	1,1,1, TRICHLOROETHANE	SOLVENT
6	DIOXIN	TIMES BEACH
4	TOBACCO	SNUFF/CIGARETTES
6	NICOTINE	CIGARETTES

AIR POLLUTION IN THE BAY AREA BY STATION AND CONTAMINANT: 1986

For ozone (O_3) and for nitrogen dioxide (NO_2), "max" is the highest hourly average value in parts per hundred million. For carbon monoxide (CO), "max" is highest 8-hour average value in parts per million. (The one-hour standard for CO was never exceeded during the year). For sulfur dioxide (SO_2), "max" is highest 24-hour average value expressed in parts per billion. For total suspended particulates (TSP), "mean" is annual geometric mean in micrograms per cubic meter. "Days" columns give number of days per year on which an air quality standard was exceeded: Federal for O_3, CO, TSP, State for NO_2 and SO_2. For TSP, Days refers to Federal 150 $\mu g/m^3$ secondary standard. The 3-year average for ozone, adjusted for instrument down-time, is the governing Federal standard (called Expected Annual Exceedance). Monitoring for O_3, CO and NO_2 is continuous: monitoring for TSP is on the Federal systematic 6-day schedule; monitoring for SO_2 includes both time scales. Compiled by the staff of the BAAQMD Meteorology and Data Analysis Section.

STATIONS	OZONE			CO		NO_2		SO_2		TSP	
	Max.	Days	3-Yr. Avg.	Max.	Days	Max.	Days	Max.	Days	Mean	Days
San Francisco	7	0	0.0	12.6*	2*	11	0	10	0	52	0
San Rafael	8	0	0.0	5.9	0	11	0	7	0	50	0
Richmond	7	0	0.0	5.0	0	13	0	8	0	38	0
Pittsburg	10	0	0.7	5.6	0	9	0	6	0	60	3
Concord	12	0	1.3	5.6	0	11	0	8	0	39	0
Oakland	9	0	0.0	7.5	0	—	—	—	—	—	—
San Leandro	8	0	1.1	—	—	—	—	—	—	—	—
Hayward	11	0	1.4	—	—	—	—	—	—	—	—
Fremont	14	2	3.7	5.6	0	14	0	7	0	48	0
Livermore	14	3	4.7	4.9	0	10	0	7	0	46	0
Alum Rock, S.J.	14	1	2.4	—	—	—	—	—	—	—	—
San Jose	14	1	3.3	11.0	4	16	0	7	0	**	**
Moorpark, S.J.	—	—	—	—	—	—	—	—	—	50	0
Gilroy	11	0	1.7	3.8	0	—	—	—	—	—	—
Los Gatos	12	0	5.7	—	—	—	—	—	—	—	—
Mountain View	13	1	0.3	—	—	—	—	—	—	—	—
Redwood City	10	0	0.3	6.4	0	13	0	3	0	44	0
Santa Rosa	8	0	0.0	5.3	0	11	0	3	0	38	0
Sonoma	10	0	0.0	—	—	—	—	—	—	—	—
Napa	9	0	0.0	6.8	0	9	0	2	0	46	1
Vallejo	9	0	1.0	10.8	4	10	0	9	0	36	0
Fairfield	9	0	0.3	—	—	—	—	—	—	—	—
DISTRICT		5			7		0		0		4

*Micro-scale site (Ellis Street) for street-level CO maximums

**Data invalid due to construction

BAAQMD 1987 TOXICS DATA SUMMARY*

BY LOCATION (PPB)

LOCATION	DCM (LOD, 0.5) <LOD	Mean	STD D.	BENZENE (LOD, 0.2) <LOD	Mean	STD D.	TCA (LOD, 0.05) <LOD	Mean	STD D.	PERC. (LOD, 0.01) <LOD	Mean	STD D.	TCE (LOD, 0.08) <LOD	Mean	STD D.	CARBON TET. (LOD, 0.01) <LOD	Mean	STD D.	TCM (LOD, 0.02) <LOD	Mean	STD D.
Fort Chron.	9	0.9	1.00	3	0.4	0.25	0	0.14	0.05	0	0.05	0.03	18	0.06	0.04	0	0.11	0.03	9	0.02	0.01
Oakland	5	1.0	0.60	1	1.1	0.65	0	0.35	0.17	0	0.27	0.18	10	0.08	0.05	0	0.11	0.01	6	0.03	0.02
San Rafael	1	1.8	0.75	0	1.4	0.54	0	0.32	0.42	0	3.98	6.30	9	0.10	0.06	0	0.10	0.02	12	0.02	0.01
Napa	4	1.0	0.58	0	1.6	0.93	0	0.23	0.08	0	0.29	0.19	8	0.12	0.10	0	0.10	0.02	3	0.04	0.02
Santa Rosa	6	1.4	1.07	0	1.4	0.91	0	0.24	0.21	0	0.17	0.20	8	0.11	0.08	0	0.10	0.02	13	0.02	0.02
Vallejo	3	1.8	1.13	2	1.4	1.28	0	0.29	0.14	0	0.41	0.39	1	0.15	0.13	0	0.10	0.02	3	0.13	0.44
San Leandro	2	2.4	1.92	0	1.8	0.91	0	0.53	0.34	0	0.24	0.15	6	0.16	0.16	0	0.10	0.02	11	0.02	0.01
Livermore	0	2.4	1.04	0	1.5	1.25	0	0.81	0.67	0	0.30	0.11	4	0.18	0.20	0	0.11	0.03	6	0.03	0.02
Fremont	2	1.5	0.80	1	1.5	1.19	0	1.10	0.76	0	0.26	0.13	5	0.12	0.06	0	0.10	0.02	6	0.03	0.02
Mt. View	1	2.4	1.92	0	1.6	0.89	0	0.04	0.23	0	0.27	0.25	5	0.12	0.07	0	0.09	0.02	4	0.05	0.03
Red. City-1	0	2.6	1.62	0	2.1	1.52	0	1.12	0.49	0	0.20	0.12	0	0.17	0.08	0	0.11	0.05	1	0.09	0.17
Red. City-2	0	2.5	2.36	0	1.6	1.09	0	1.59	0.95	0	0.18	0.11	0	0.20	0.11	0	0.10	0.02	1	0.10	0.16

TABLE 3. SELECTED POTENTIALLY HAZARDOUS CHEMICALS IN DRINKING WATER

Chemical	Detectable Quantities[b] in New Orleans	Miami	Seattle	Ottuma	Philadelphia	Cincinnati[c]	Tucson[c]
Acetylene dichloride	+	+ (17)			+ (0.1)	+ (0.1)	
Benzene[d]	+	+ (0.1)		+ (0.1)	+ (0.2)	+ (0.3)	
Bis(2-chloroethyl) ether[c,d]	+				+ (0.5)		
Bromodichloromethane	+	+ (73)	+ (4)	+	+ (20)	+ (15)	
Bromoform	+ (0.57)	+ (1.5)					+ (3.0)
Carbon disulfide[f]	+	+			+	+	
Carbon tetrachloride[d,e]	+	+		+	+	+	
Chlorobenzene	+	+ (1.0)	+	+	+ (0.1)	+ (0.5)	
Chloroform[d,e]	+ (133)	+ (311)	+ (21)	+ (1.0)	+ (65)	+ (38)	+ (0.08)
Chloropicrin		+ (0.4)			+ (2)	+ (3)	
Cyanogen chloride		+		+	+	+	
Dibromochloromethane	+ (1.1)	+ (32)	+ (3)		+ (5)	+ (3)	+ (0.01)
Dibutyl phthalate[f]	+ (0.1)	+ (5)	+ (0.01)	+ (0.1)	+ (0.05)		
Diethyl phthalate[f]	+ (0.03)	+ (1.0)	+ (0.01)		+ (0.01)	+ (0.1)	
1,2-Dichlorobenzene	+ (0.01)[g]	+ (1.0)			+	+	
1,3-Dichlorobenzene		+ (0.5)			+	+	
1,4-Dichlorobenzene		+ (0.5)			+	+	
1,2-Dichloroethane[e]	+	+			+	+	
Hexachloroethane	+ (4.4)	+ (0.5)					
Methylene chloride	+	+	+	+	+	+	
Dieldrin[d,e]	+ (0.05)	+ (0.002)	+ (0.001)	+ (0.002)		+ (0.001)	
Lindane[d]						+ (0.1)	
1,1,1-Trichloroethane[e]				+	+	+	
Trichloroethylene[d,e]	+	+ (0.3)		+ (0.1)	+ (0.5)	+ (0.1)	
Tetrachloroethylene[e]	+	+ (0.1)		+ (0.2)	+ (0.4)	+ (0.3)	
Vinyl chloride[d]		+ (5.6)			+ (0.27)		
Vinylidene chloride		+ (0.1)			+ (0.1)	+	

TABLE 1. TOXICANT CONCENTRATIONS OF REGULATORY OR REFERENCE SIGNIFICANCE

Minerals	System Component	Concentration	Ref
Arsenic	Raw waters	0.1	a
	Community water systems	0.05	b
Barium	Raw waters	1.0	a
	Community water systems	1.0	b
Cadmium	Raw waters	0.01	a
	Community water systems	0.01	b
Chromium	Raw waters	0.05	a
	Community water systems	0.05	b
Copper	Raw waters	1.0	a
	Bottled water	1.0	c
Cyanide	Raw waters	0.2	a
	Bottled water	0.2	c
Fluoride	Raw water		a
	Community water systems		b
	5 Year Average Maximum Ambient Air Temperature (°C)		
	<12.0 - 12.0	2.4	
	12.1 - 14.6	2.2	
	14.7 - 17.6	2.0	
	17.7 - 21.4	1.8	
	21.5 - 26.2	1.6	
	26.3 - 32.5	1.4	
Iron	Raw waters	0.3	a
	Bottled water	0.3	c
Lead	Raw waters	0.05	a
	Community water systems	0.05	b
Manganese	Raw waters	0.05	a
	Bottled water	0.05	c
Mercury	Fish, shellfish, crustaceans, and other aquatic animals, edible portion, fresh or processed	1.0	d
	Raw waters	0.002	a
	Community water systems	0.002	b
Nitrate - As NO_3^-	Bottled water	45.0	c
As N	Raw waters	10.0	a
	Community water systems	10.0	b
Nitrate as N	Raw waters	1.0	a
Selenium	Raw waters	0.01	a
	Community water systems	0.01	b
Silver	Community water systems	0.05	b
Sulfate	Raw waters	250.0	a
	Bottled water	250.0	c
Zinc	Raw waters	5.0	a
	Bottled water	5.0	c

Organic Compounds	System Component	Concentration	Ref.
Halogenated hydrocarbons			
Aldrin and dieldrin	Fish and shellfish, edible portion, fresh or processed	0.3	d
	Animal feed, processed	0.03	d
	Navigable waters	0.003	e
	Raw waters	0.001	a
Benzene hexachloride	Frog legs, edible portion	0.5	d
	Animal feed, processed	0.1	d
Chlordane	Animal fat, rendered	0.8	d
	Animal feed, processed	0.1	d
	Raw waters	0.003	a
DDT, TDE, DDE	Fish, raw or processed	5.0	d
	Animal feed, processed	0.5	d
	Raw waters	0.05	a
	Navigable waters	0.001	e
Endrin	Fish meal, solubles, and oil for animal feed	0.3	3
	Fish and shellfish, raw or processed	0.3	d
	Animal feed, processed	0.03	d
	Navigable waters	0.004	e
	Raw waters	0.0005	a
	Community water system	0.0002	b
Heptachlor- and Heptachlor epoxide	Fish and shellfish, fresh or processed	0.3	d
	Animal feed, processed	0.03	d
	Raw waters	0.0001	a
Lindane	Animal feed, processed	0.1	d
	Raw waters	0.005	a
	Community water systems	0.004	b
Methoxychlor	Raw waters	1.0	a
	Community water systems	0.1	b
Mirex	Fish	0.1	d
Polychlorinated biphenyls	Fish and shellfish, edible portion	5.0	f
	Fish meal and other marine products for animal feed	2.0	f
	Finished feed formulas	0.2	f
	Navigable waters	0.001	e
Toxaphene	Fish, raw and processed	5.0	d
	Animal feed, processed	0.5	d
	Navigable waters	0.005	e
	Raw waters	0.005	a
	Community water systems	0.005	b
Chlorophenoxys			
2,4-Dichlorophenoxy acetates (2,4-D)	Raw waters	0.2	a
	Community water systems	0.1	b
2,4,5-Trichlorophenoxy acetates (2,4,5-T)	Raw waters	0.002	a
2,4,5-Trichlorophenoxy propionates (2,4,5-TP)	Raw waters	0.03	a
	Community water systems	0.01	b
Total carbamate and organophosphate pesticides	Raw waters	0.1	a
Kepone	Crabs, fresh and frozen edible portion	0.4	d
	Fish and shell fish, edible portion, fresh or processed	0.3	d
Herbicides, If Used for Aquatic Weed Control			
Diquat	Potable water	0.01	g
Endothall	Potable water	0.2	g
Glyphosate	Potable water	0.1	g
Phenols	Raw waters	0.001	a
	Bottled water	0.001	c
Benzidine	Navigable waters	0.1	e
Unidentified Organics			
Carbon, chloroform extractable	Raw waters	0.3	a
Carbon, alcohol Extractable	Raw waters	1.5	a

Table I. Metallic Composition of the Earth's Crust

Element	Content (ppm)
Iron (Fe)	50,000
Sodium (Na)	28,300
Potassium (K)	25,900
Magnesium (Mg)	20,900
Manganese (Mn)	1,000
Barium (Ba)	250
Chromium (Cr)	200
Vanadium (V)	150
Zinc (Zn)	132
Nickel (Ni)	80
Copper (Cu)	70
Cobalt (Co)	23
Lead (Pb)	16
Molybdenum (Mo)	15
Mercury (Hg)	0.5
Cadmium (Cd)	0.15

[a]Modified from the table in *Handbook of Chemistry and Physics*[1]

Table II. Elemental Composition of Living Matter[a]

Element	Weight (%)
Oxygen (O)	76.0
Carbon (C)	10.5
Hydrogen (H)	10.0
Nitrogen (N)	2.5
Phosphorus (P)	0.3
Potassium (K)	0.3
Chlorine (Cl)	0.1
Sodium (Na)	0.04
Calcium (Ca)	0.02
Magnesium (Mg)	0.02
Sulfur (S)	0.02
Iron (Fe)	0.01

[a]From Jessop, N. M. *Bioshpere: A Study of Life* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970), p. 339 (reproduced with permission of publishers).[2]

Table IV. Metal Contents of "Average Man"[a]

Metal	Content (mg/70-kg man)
Iron	4000-4200
Zinc	2300
Copper	72-100
Manganese	12-20
Lead	18-120
Cadmium	20-50
Mercury	13
Cobalt	1.5-3

[a]Modified from Tables I-III in Woolrich, P. F. "Occurrence of Trace Metals in the Environment. An Overview," *Am. Ind. Hyg. Assoc. J.* 34:217 (1973) (reproduced by permission).

TABLE II
Hazard Comparison with Beer and Wine
(Based on Data from Ames, *et al.*[1])

Daily Human Exposure	Times Less Hazardous than 1 Glass of	
	Beer	Wine
Tap water (1 L)	28 000	4700
Contaminated well water (1 L) (worst well in Silicon Valley)	700	1200
Well water (1 L, Woburn, Mass.)	7000 A. 14 000 B. 9300	12 000 A. 24 000 B. 16 000
Swimming pool (1 hr) (average child)	350	590
Conventional home air (14 hr/day)	A. 4.7 B. 700	7.8 12 000
Mobile home air (14 hr/day)	1.3	2.2
PCBs: daily dietary intake	14 000	24 000
DDE/DDT: daily dietary intake	9300	1600
EDB: daily dietary intake (from grains and grain products)	7000	1200
Bacon, cooked (100 gm)	A. 930 B. 467	A. 1600 B. 780
Sake (250 mL)	930	1600
Comfrey herb tea (1 cup)	93	160
Peanut butter (32 gm: one sandwich)	93	160
Dried squid, broiled in gas oven (54 gm)	47	78
Brown mustard (5 gm)	40	67
Basil (1 gm dried leaf)	28	47
Mushroom (*Angaricus bisporus*), one raw (15 gm)	28	47
Natural root beer (354 mL) (now banned)	56	24
Beer before 1979 (12 oz)	350	590
Beer (12 oz)	1	1.7
Wine (250 mL)	0.59	1
Diet cola (12 oz)	47	78
Formaldehyde: Workers' daily average intake	0.48	0.81
EDB: Workers' daily intake (high exposure)	0.002	0.03

(Please refer to Table I for additional detail.)

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COMMON POISONOUS PLANTS

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HOUSE PLANTS

Plant	Toxic Part	Symptoms
Hyacinth, Narcissus, Daffodil	Bulbs	Nausea, vomiting, diarrhea. May be fatal.
Oleander	Leaves, Branches	Extremely poisonous. Affects the heart, produces severe digestive upset and has caused death.
Poinsettia	Leaves	Fatal. One leaf can kill a child.
Dieffenbachia (Dumb cane) Elephant ear	All parts	Intense burning and irritation of the mouth and tongue. Death can occur if base of the tongue swells enough to block the air passage of the throat.
Rosary pea, Castor bean	Seeds	Fatal. A single rosary pea seed has caused death. One or two castor bean seeds are near the lethal dose for adults.
Mistletoe	Berries	Fatal. Both children and adults have died from eating the berries.

FLOWER GARDEN PLANTS

Larkspur	Young plant, Seeds	Digestive upset, nervous excitement, depression. May be fatal.
Monkshood	Fleshy roots	Digestive upset and nervous excitement.
Autumn crocus, Star-of-Bethlehem	Bulbs	Vomiting and nervous excitement.
Lily-of-the valley	Leaves, Flowers	Irregular heart beat and pulse, usually accompanied by digestive upset and mental confusion.
Iris	Underground stems	Severe, but not usually serious, digestive upset.
Foxglove	Leaves	One of the sources of the drug digitalis, used to stimulate the heart. In large amounts, the active principles cause dangerously irregular heartbeat and pulse, usually digestive upset and mental confusion. May be fatal.
Bleeding heart (Dutchman's breeches)	Foliage, Roots	May be poisonous in large amounts. Has proved fatal to cattle.

VEGETABLE GARDEN PLANTS

Rhubarb	Leaf blade	Fatal. Large amounts of raw or cooked leaves can cause convulsions, coma, followed rapidly by death.

ORNAMENTAL PLANTS

Daphne	Berries	Fatal. A few berries can kill a child.
Wisteria	Seeds, Pods	Mild to severe digestive upset. Many children are poisoned by this plant.
Golden chain	Bean-like capsules in which the seeds are suspended	Severe poisoning. Excitement, staggering, convulsions and coma. May be fatal.

Plant	Toxic Part	Symptoms
Laurels, Rhododendron, Azaleas	All parts	Fatal. Produces nausea and vomiting, depression, difficult breathing, prostration and coma.
Jessamine	Berries	Fatal. Digestive disturbance and nervous symptoms.
Lantana camara (red sage)	Green berries	Fatal. Affects lungs, kidneys, heart and nervous system. Grows in the southern U.S. and in moderate climates.
Yew	Berries, Foliage	Fatal. Foliage more toxic than berries. Death is usually sudden without warning symptoms.

TREES AND SHRUBS

Wild and cultivated cherries	Twigs, Foliage	Fatal. Contains a compound that releases cyanide when eaten. Gasping, excitement, and prostration are common symptoms that often appear within minutes.
Oaks	Foliage, Acorns	Affects kidneys gradually. Symptoms appear only after several days or weeks. Takes a large amount for poisoning. Children should not be allowed to chew on acorns.
Elderberry	All parts, especially roots	Children have been poisoned by using pieces of the pithy stems for blowguns. Nausea and digestive upset.
Black locust	Bark, sprouts, foliage	Children have suffered nausea, weakness and depression after chewing the bark and seeds.

PLANTS IN WOODED AREAS

Jack-in-the-pulpit	All parts, especially roots	Like dumb cane, contains small needle-like crystals of calcium oxalate that cause intense irritation and burning of the mouth and tongue.
Moonseed	Berries	Blue, purple color, resembling wild grapes. Contains a single seed. (True wild grapes contain several small seeds.) May be fatal.
Mayapple	Apple, foliage, roots	Contains at least 16 active toxic principles, primarily in the roots. Children often eat the apple with no ill effects, but several apples may cause diarrhea.

PLANTS IN SWAMP OR MOIST AREAS

Water hemlock	All parts	Fatal. Violent and painful convulsions. A number of people have died from hemlock.

PLANTS IN FIELDS

Buttercups	All parts	Irritant juices may severely injure the digestive system.
Nightshade	All parts, especially the unripe berry	Fatal. Intense digestive disturbances and nervous symptoms.
Poison hemlock	All parts	Fatal. Resembles a large wild carrot. Used in ancient Greece to kill condemned prisoners.
Jimson weed (thorn apple)	All parts	Abnormal thirst, distorted sight, delirium, incoherence and coma. Common cause of poisoning. Has proved fatal.

GPO 906-757

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CHEMICAL HAZARDS IN THE HOME

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Product	Possible Hazards	Disposal Suggestions	Precautions and Substitutes
Aerosols	When sprayed, contents are broken into particles small enough to be inhaled. Cans may explode or burn.	Put **only** empty cans in trash. Do not burn. Do not place in trash compactor.	Store in cool place. Propellant may be flammable. Instead: use non-aerosol products.
Batteries: mercury button type	Swallowing one may be fatal if it leaks. *Toxicity 5**	Throw in trash.	No substitutes.
Bleach: chlorine	Fumes irritate eyes. Corrosive to eyes & skin. Poisonous if swallowed. *Toxicity 3**	Use up according to label instructions.	NEVER MIX WITH AMMONIA! Instead: use non-chlorine bleach or other laundry additive, sunlight, lemon juice.
Detergent cleaners	All are corrosive to some degree. Eye irritant. Toxicity varies. *Toxicity 2-4**	Use up according to label instructions or give away. May be diluted & washed down sink.	Instead: use the mildest product suitable for your needs. Liquid dishwashing detergent is mildest, laundry detergent is moderate, automatic dishwasher detergent is harshest.
Disinfectants	Eye & skin irritant. Fumes irritating. Poisonous if swallowed. *Toxicity 3-4**	Use up according to label instructions or dilute & pour down sink.	Some may contain bleach, others ammonia — DO NOT MIX! Instead: use detergent cleaners whenever possible.
Drain cleaners	Very corrosive. May be fatal if swallowed. Contact with eyes can cause blindness.	Use up according to label instructions.	Prevention best; keep sink strainers in good condition. Instead: use plunger, plumber's snake, vinegar & baking soda followed by boiling water.
Flea powders, sprays & shampoos	Moderately to very poisonous. *Toxicity 2-4**	Use up or save for hazardous waste collection day.	DO NOT USE DOG PRODUCTS ON CATS. Vacuum house regularly & thoroughly. Launder pet bedding frequently.
Insect and pest sprays	All are poisonous, some extremely so. May cause damage to kidneys, liver, or central nervous system. Toxicity varies from product to product.	Use very carefully & according to label instructions. Save for hazardous waste collection day.	Instead: do not attract insects; keep all food securely covered, practice good sanitation in kitchen & bathrooms, remove trash every night.
Medicines: unneeded or expired	Frequently cause child poisonings.	Flush down sink or toilet.	Check contents of medicine chest regularly. Old medications may lose their effectiveness, but not necessarily their toxicity.
Metal polishes	May be flammable. Mildly to very poisonous. *Toxicity 2-4**	Use up according to label instructions or give away.	Use only in well-ventilated area. Instead: substitute vinegar & salt or use baking soda on damp sponge.
Mothballs	Some are flammable. Eye & skin irritant, poisonous, may cause anemia in some individuals.	Use up according to label instructions or give away.	Do not use in living areas. Air out clothing and other items before use. Clean items before storage. Instead: use cedar shavings or aromatic herbs.
Oven cleaner	Corrosive. Very harmful if swallowed. Irritating vapors. Can cause eye damage. *Toxicity 2-4**	Use up according to label instructions or give away. Save for hazardous waste collection day.	Do not use aerosols, which can explode and are difficult to control. Instead: use paste. Or heat oven to 200 degrees, turn off, leave small dish of ammonia in oven overnight, then wipe oven with damp cloth and baking soda. Do not put baking soda on heating elements.
Toilet bowl cleaner	Corrosive. May be fatal if swallowed. *Toxicity 3-4**	Use up according to label instructions or wash down the sink or toilet with lots of water.	Ventilate room. Instead: use ordinary cleanser or detergent and baking soda.
Window cleaner	Vapor may be irritating. Slightly poisonous. *Toxicity 2**	Use up according to label instructions or give away.	Ventilate room. Instead: spray on vinegar, then wipe dry with newsprint.
Wood cleaners, polishes, & waxes	Fumes irritating to eyes. Product harmful if swallowed. Eye & skin irritant. Petroleum types are flammable.	Use up according to label instructions or save for hazardous waste collection day.	Do not use aerosols. Use only in well-ventilated areas. Instead: use lemon oil or beeswax.

***General Toxicity Ratings**

Number Rating	1	2	3	4	5	6
Toxicity Rating	Almost Non-Toxic	Slightly Toxic	Moderately Toxic	Very Toxic	Extremely Toxic	Super Toxic
Lethal Dose for 150 lb. Adult	More than 1 Quart	1 Pint to 1 Quart	1 Ounce to 1 Pint	1 Teaspoon to 1 Ounce	7 Drops to 1 Teaspoon	Less Than 7 Drops

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CHEMICAL HAZARDS IN THE GARAGE AND WORKSHOP

M

Product	Possible Hazards	Disposal Suggestions	Precautions and Substitutes
Aerosols	When sprayed, contents are broken into particles small enough to be inhaled. Cans may explode or burn.	Put **only** empty cans in trash. Do not burn. Do not place in trash compactor.	Store in cool place. Propellant may be flammable. Instead: use non-aerosol products.
Asphalt roofing compound	Eye irritant. Fumes moderately toxic. *Toxicity 3**	Use up according to label instructions or give away.	No substitutes. Do not use indoors.
Auto: antifreeze	Very poisonous. Has sweet taste — attractive to small children & pets. *Toxicity 3-4**	Amounts of less than 1 gallon pour down sink with plenty of water. Do **not** do this if you have a septic tank. Put in a secure container & take to a garage or service station.	No substitutes. Clean up any leaks or spills carefully.
Auto: batteries	Contain strong acid. Very corrosive. Danger to eyes & skin.	Recycle.	No substitutes. Trade in old batteries.
Auto: degreasers	Corrosive. Poisonous. Eye & skin irritant. *Toxicity 2-4**	Use up according to label instructions.	Choose strong detergent type over solvent type.
Auto: motor oil & transmission fluid	Poisonous. May be contaminated with lead. Skin & eye irritant.	Recycle.	No substitutes.
Auto: waxes & polishes	Fumes irritating to eyes. Harmful if swallowed. Eye & skin irritant.	Use up according to label instructions or give away.	Use outside.
Lacquer & lacquer thinner	Extremely flammable. Very poisonous. *Toxicity 4**	Use up according to label instructions or save for hazardous waste collection day.	Ventilate area very well. Do not use in room with pilot light, open flame, electric motors, spark-generating equipment, etc. DO NOT SMOKE WHILE USING.
Paint strippers, thinners, & other solvents	Many are flammable. Eye & skin irritant. Moderately to very poisonous. *Toxicity 3-4**	Let settle, pour off cleaner for re-use. Pour sludge into container & seal, or wrap well in newspaper & throw in trash. Use up according to label instructions or save for hazardous waste collection day.	Avoid aerosols. Buy only as much as you need. Ventilate area well. Do not use near open flame. Instead of paint stripper: sand or use heat gun. Use water cleanup products as much as possible.
Paints, oil-based, & varnishes	Flammable. Eye & skin irritant. Use in small, closed area may cause unconsciousness.	Use up according to label instructions or save for hazardous waste collection day.	Ventilate area well. Do not use near open flame. May take weeks for fumes to go away. Instead: use water-based paints if possible.
Pesticides, herbicides, fungicides, slugbait, rodent poison, wood preservatives**	All are dangerous to some degree. Can cause central nervous system damage, kidney & liver damage, birth defects, internal bleeding, eye injury. Some are readily absorbed through the skin. *Toxicity 3-6**	Use up carefully, following label instructions. Save for hazardous waste collection day.	Do not buy more than you need. Instead: try hand-picking, mechanical cultivation, natural predators. Practice good sanitation. Choose hardy varieties. Use insect lures & traps. As a last resort, use least toxic suitable pesticides.

**Some pesticides have been banned or restricted. These pesticides should be carefully stored and saved for a hazardous waste collection day. A partial list of these products follows:
Aldrin, Amitraz, Arsenic Trioxide, Benomyl, BHC, Bithionol, Chloranil, Chlordane, Chlorobenzilate, Copper Arsenate, DBCP, DDD(TDE), DDT, Diallate, Dieldrin, Dimethoate, EDB, Endrin, EPN, Fluorocetamide, Heptachlor, Kepone, Lindane, Mercury, Mirex, OMPA, Parathion, Polychlorinated Biphenyls, Phenarzine Chloride, Pronamide, Safrole, Silvex, Sodium Arsenite, Sodium Cyanide, Sodium Fluoroacetate, Strobane, Strychnine, Thallium Sulfate, TOK, Toxaphene, Trifluralin, Vinyl Chloride.

***General Toxicity Rating**

Number Rating	1	2	3	4	5	6
Toxicity Rating	Almost Non-Toxic	Slightly Toxic	Moderately Toxic	Very Toxic	Extremely Toxic	Super Toxic
Lethal Dose for 150 lb. Adult	More than 1 Quart	1 Pint to 1 Quart	1 Ounce to 1 Pint	1 Teaspoon to 1 Ounce	7 Drops to 1 Teaspoon	Less Than 7 Drops

For more information, contact your local public works department, hazardous waste agency, or poison control center.