Health Effects

of Selected Industrial Chemicals and Radionuclides: *an introduction*

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Health Effects
of Selected Industrial Chemicals and Radionuclides: *an introduction*

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Introduction

The purpose of this report is to provide information about the health hazards that exposures to industrial chemicals and radionuclides may pose to the community. Sources of additional information are provided in Appendix 3. In this way, the community might better understand the heath issues and hazards related to these chemicals and contaminants.

Determining and classifying health hazards to humans exposed to varying amounts of contaminants is difficult and subtle. The risks of serious illness as a function of exposure is not the same for all compounds, and one should not be misled by the similarities of the health effects due to the different toxic chemicals inventoried in this report. The quantitative aspects of exposure are as important as the seriousness of the health consequences. Indeed, the geographical spread of the contaminants and their temporal evolutions would also vary; leading us to naturally consider the seriousness of contamination as a function of quantity, consequences, and also temporal evolution. Therefore, the notion of "acceptable" risk levels for a site goes much further than just establishing a list of contaminants and their legal dose limits.

Some of the reasons that make the understanding of "acceptable" exposure more subtle than it first appears are provided below.

Regulating Agencies and Guidelines

The federal government is charged with developing regulations and recommendations to protect public health. These regulations can be enforced by law.

Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

It is important to remember in this regard that as far as radioactive materials are concerned, the Department of Energy (DOE) regulates

its own facilities. Through its contractors, DOE also operates these facilities. DOE funds health studies that determine the hazard of radioactive materials.

National Primary Drinking Water Regulations are determined by the EPA for certain toxic and radioactive chemicals. These regulations, known as the Maximum Contaminant Level (MCL), are legally enforceable in the United States. These legal standards set limits to the amount of contamination in the public drinking water supply.

Many other agencies study the effects and patterns of some toxic materials, such as the World Health Organization (WHO), the International Agency for Research on Cancer (IARC), and the United States Department of Health and Human Services (US DHHS). These organizations recommend limits on the concentrations, or amounts, of contamination to be allowed in drinking water.

In this report, many of the chemicals discussed do not have assigned MCLs. In these cases, additional guidelines are provided. The American Conference of Governmental Industrial Hygienists (ACGIH) has set Threshold Limit Values (ACGIH TLV); these values are time-weighted averages to which a worker can be exposed in a normal 8-hour day, 40-hour workweek without any effect on human health. The NIOSH has determined Recommended Exposure Limits (REL) which are guidelines based on risk evaluations using human health effects for levels feasibly achieved and measured by engineering controls. However, these two guidelines are difficult to compare. In addition, the WHO has set its own recommended levels for contaminants allowed in drinking water.

Standards

Regulations and recommendations can be expressed in "not-to-exceed" levels in air, water, soil, or food that are usually based on levels that affect animals, then adjusted to protect people. Sometimes these "not-to-exceed" levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors. Recommendations and regulations are also periodically updated and change as more information becomes available. Unfortunately, the number of new chemicals introduced into the workplace each year numbers in the hundreds or thousands, completely over-whelming the ability of federal agencies to determine the hazards of each.

So, it is not uncommon that different studies reach different conclusions about which contaminants are most prevalent or of highest priority. Similarly, the Hazard Rating (HR) assigned to each material in the form of a number (1, 2, and 3) that briefly identifies the level of toxicity or hazard varies according to different agencies and organizations.

Factors

When a substance is released from a large area, such as an industrial plant, or a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. One can be exposed to a substance only when in contact with it by breathing, eating, touching, or drinking. The consequences may vary in each case.

When exposed to a chemical, many factors determine whether a person would likely be harmed or not. These factors include the dose (how much), the duration (how long), the form (which chemical compound), and the way the contact occurs. Other important parameters could be the presence of other chemicals that enhance or diminish the toxicity, and the age, sex, diet, family traits, lifestyle, and state of health of the person. Therefore, classifying the health hazards to humans becomes difficult and research-intensive. Varying test environments and procedures will alter results in the patient. Also, health effects for the majority of these chemicals are better known for animals than humans. The same effects seen in animals may also be seen in humans to some extent. However, humans do not react in the same way when exposed to the same chemicals and, therefore, more research is needed to determine the full extent of harm to human health.

In addition, medical tests on individuals to detect and evaluate exposures to a chemical may have used various “techniques” and resulted in contradictory results. Measurements in the blood, feces, or urine can determine if one has been exposed to larger-than-normal amounts of chemicals. But these measurements will obviously depend on each individual, their overall health and how long after the exposure the measurement is taken.

It is difficult to obtain information on target organs. For example, all the persons suspected of having died prematurely because of a precise exposure have not necessarily been autopsied so the information

about which organs have been partially or completely damaged is lacking.

Further, correlations can be difficult to establish. An organ may not be lethally damaged, but its malfunction could accelerate the deterioration of another part of the body and lead to a fatality. For example, smoking or chronic bronchitis due to exposure to dust would make a person more sensitive to radioactivity.

Fetuses, children, and adults also exhibit different susceptibilities to various contaminants.

Cancer Reviews and Classifications

Along with other agencies, the U.N. International Agency for Research on Cancer (IARC) examines suspected potential carcinogens. The results, which vary widely between animals and humans, usually fall into one of three groups defined as follows:

1) Class I – Confirmed Carcinogens
   These substances are capable of causing cancer in exposed humans.

2) Class II – Suspected Carcinogens
   These substances may be capable of causing cancer in exposed humans. The evidence is suggestive, but not sufficient to convince expert review committees. Some entries have not yet had expert review, but contain experimental reports of carcinogenic activity.
   As more studies are published, many Class II carcinogens will have their carcinogenicity confirmed. On the other hand, some may be judged non carcinogenic.

3) Class III – Questionable Carcinogens
   These entries have minimal published evidence of possible carcinogenic activity. The reported endpoint is often neoplastic growth with no spread or invasion characteristic of carcinogenic pathology.

   It should be noted that these three categories refer only to the strength of the experimental evidence that a chemical is carcinogenic, and not to the extent of its carcinogenic activ-

ity nor to the mechanism involved. The classification of any chemical may change as new information becomes available.

For a substance to belong in Class III, the report may simply have lacked control animals, may have used a very small sample size, lacked complete pathology reporting, or may have suffered other design defects. Many of these were designed for other-than-carcinogenic evaluation, and the reported carcinogenic effect is a by-product of the study, not the goal. The data were presented because some of the substances may be carcinogens. There are simply insufficient data to affirm or deny the possibility.

Synergistic Effects of Multiple Contaminants

Complicating the assessment of toxicity for a contaminated site is the presence of a mixture of contaminants. Aggregated chemicals could mean aggregated risks.

In a survey of 91 DOE waste sites, for example, Riley and Zachara (1992) found that mixtures of two or more compounds were present at 65 % of the sites. In soils, the most frequently occurring mixtures were metals combined with radionuclides, but various combinations of metals and radionuclides with organic contaminants were also observed at some sites. In groundwater, the most common mixtures were metals and chlorinated hydrocarbons.

The consequences of the synergy, linked to the presence of several contaminants at a time in a contaminated site, still need to be thoroughly examined. Chemical and radioactive risks are generally increased if these substances are carcinogenic to the same organ.

Other auxiliary parameters may also interfere with the total toxic impact of chemicals, and should not be underestimated. For example, a smoker with damaged cilia in his lung passages will not be able to properly expel radioactive materials, and therefore could be subject to greatly increased health effects. Weather and temperature, for example, may also have favorable or deleterious consequences.

Chlorinated Solvents

A solvent is typically a liquid that dissolves another substance, thereby forming a solution. A chlorinated solvent is one that is a chlorine compound. As chlorinated solvents move through the ground, the materials act as an oily liquid. Groundwater flowing in the soil will dissolve only a small portion of the contaminant and the rest enters and contaminates the groundwater.

A dioxin is a specific type of chlorinated solvent; dioxins are a group of 219 different toxic chlorinated solvents. These solvents are fat-soluble and therefore accumulate in the tissues of animals and humans in the food chain. Humans are typically exposed to these chemicals through the consumption of fish, meat, and milk. Dioxins are formed through the burning of chlorine-based compounds. Dioxins may be transported great distances if airborne. Materials that enter the water will bind to sediments and are transported along with marine wildlife through ingestion. Similarly, dioxins can settle on the leaves of plants and are ingested by animals.

Exposure results in a drop in sperm count, an increase in testicular and prostate cancer, endometriosis, and an increased risk of developing breast cancer. The toxicity of these chemicals varies but dioxins have similar potencies.[1] Results of exposure to dioxins create adverse health effects and vary depending on the level of exposure, time of exposure, and length of exposure. Typical effects as a result of exposure to large amounts of dioxin include skin rashes, skin discoloration, excessive body hair, and possibly mild liver damage. Cancer as a result of excessive dioxin exposure is a main concern in adults.

Although the carcinogenicity of chlorinated solvents remains unknown, cancer as a result of exposure is a great concern.

Carbon Tetrachloride

Carbon tetrachloride**,** also known as carbon chloride, methane tetrachloride, perchloromethane, tertrachloroethane, or benziform, is a clear liquid with a sweet smell that can be detected at low-levels. This synthetic chemical was most typically used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as

a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. It is now only used in some industrial applications as a result of its harmful health effects. High-levels of exposure through inhalation and ingestion and possibly through exposure to the skin can cause liver, kidney, and central nervous system damage. The liver and kidney cells are damaged or destroyed by this chemical. Kidney and liver repair can occur when low-levels of exposure are stopped. High-levels of exposure affect the nervous system, including the brain. This chemical has been linked to brain cancer. Effects of exposure include: headaches, intoxication, dizziness, drowsiness, nausea, and vomiting, and can lead to coma and even death. The US DHHS has determined this chemical is a probable carcinogen. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 5 ppm. The NIOSH REL is set at 2 ppm or 12.6 mg/m^3.

Chloride

Chloride has a very low toxicity. Ingestion of large amounts of chloride may lead to fluid retention and altered acid-base balance. Chlorine as a gas or liquid is irritating and toxic. The main source of exposure is through the consumption of salt. Effects of long-term exposure are unknown.

Chlorobenzene

Chlorobenzene, also known as benzene chloride, was used to make other chemicals such as phenol and DDT. Currently, this chemical is used as a solvent to make other chemicals. This chemical is a strong narcotic with slight irritant qualities. Health effects from repeated low-levels of exposure are unknown. Symptoms of exposure include: irritation to the eyes, skin, and nose, drowsiness, incoordination, and central nervous system depression. The carcinogenicity of this chemical is unknown. The ACGIH TLV is set at 10 ppm.

Chloroform

Chloroform**,** also known as trichloromethane and methyl trichloride, is a colorless liquid with a pleasant, nonirritating odor and a slightly sweet taste. This chemical will burn only when it reaches very high temperatures. Initially, chloroform was used as an anesthetic. Currently, it is used to make other chemicals. Inhalation results in irritation to the respiratory tract, and effects on the central nervous system including headache, drowsiness, and dizziness. Results of inhalation may also lead to unconsciousness, liver injury, blood disorders, and even death. Ingestion results in severe burning to the mouth and

throat, vomiting and similar results as inhalation. Sores develop on skin with contact to large amounts of chloroform. The US DHHS declares chloroform to be a probable carcinogen. The MCL is not determined for this chemical, but the ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 2 ppm or 9.78 mg/m^3.

Chloromethane

Chloromethane is also known as methyl chloride. Symptoms often seen include: convulsions, nausea or vomiting, dizziness, drowsiness, incoordination, confusion, abdominal pains, hiccoughs, diplopia, delirium, convulsions, irritation to the eye, coma, and even death. High levels of exposure greatly affect the nervous system, liver, kidneys, and heart. No evidence exists to imply that chloromethane is a carcinogen. However, the EPA has determined that it is a probable carcinogen. The ACGIH TLV is set at 50 ppm. The NIOSH REL is set at 100 ppm.

Dibromochloromethane

Dibromochloromethane is also known as chlorodibromomethane. Symptoms often seen include: irritation and narcotic effects. No cases of cancer are seen in humans exposed to this chemical. The MCL for this chemical is set at 0.10 ppm.

Dichlorodifluoromethane

Dichlorodifluoromethane exposure symptoms often seen include: dizziness, tremor, asphyxia, unconsciousness, cardia arrhythmias, cardiac arrest, conjunctiva irritation, fibrosing alveolitis, liver changes, and narcotic effects. The ACGIH TLV and NIOSH REL are set at 1000 ppm.

Freon-113

Freon-113, also known as 1,1,2-Trichloro-1,2,2-trifluoroethane, is a mildly toxic chemical. Symptoms often seen include: irritation to skin and throat, drowsiness, dermatitis, and central nervous system depression. The NIOSH REL is set at 1000 ppm.

Methylene Chloride

Methylene Chloride**,** also known as dichloromethane, is not found naturally in the environment. This chemical is a colorless liquid with a mild, sweet odor used as an industrial solvent and paint stripper. Inhalation of low-levels results in a person becoming less attentive and less accurate. Effects of inhalation at high-levels have a narcotic

effect. Symptoms often seen include: dizziness, nausea, mental confusion, fatigue, vomiting, headaches, and a tingling sensation in the fingers and toes. Contact with this chemical by skin results in irritation, redness, pain, and even burning. The WHO declares methylene chloride as carcinogenic to humans. The US DHHS and the EPA have determined that this chemical is a probable carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 50 ppm.

Octachlorodibenzo-p-dioxin (OCDD)
Octachlorodibenzo-p-dioxin (OCDD) is an experimental teratogen and an irritant to the eye. Ingestion of this chemical results in poisoning. These solvents are fat-soluble and therefore accumulate in the tissues of animals and humans in the food chain. Humans are typically exposed to these chemicals through the consumption of fish, meat, and milk. Exposure to dioxins results in a drop in sperm count, an increase in testicular and prostate cancer, endometriosis, and an increased risk of developing breast cancer. The MCL and ACGIH TLV have not been determined for this chemical.

Pentachlorinated dibenzofurans
Pentachlorinated dibenzofurans is a chemical with great health effects to the human body. A significant reduction of thymus weight and suppression of the activity of cytotoxic T lymphocytes, in addition to a suppression on both cell-mediated and humoral immunity. The MCL and ACGIH TLV have not been determined for this chemical.

Perchloroethylene (PCE)
PCE, also known as perchloroethylene or tetrachloroethylene, is a moderately toxic chemical. Inhalation results in conjunctiva irritation, general anesthesia, hallucinations, distorted perceptions, local anesthesia, coma, and pulmonary changes. Symptoms of exposure may include irritation to eyes, skin, nose, throat, and respiratory system, as well as nausea, dizziness, incoordination, headache, drowsiness, skin erythema, and liver damage. Ingestion results in irritation to the gastrointestinal tract. This chemical is a potential carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 50 ppm. The NIOSH REL recommends that workplace exposure is minimized.

Titanium tetrachloride
Titanium tetrachloride is a colorless to pale yellow liquid that has fumes with a strong odor. If it comes in contact wit water, it rapidly forms hydrochloric acid, as well as titanium compounds. It is not found naturally in the environment and is made from minerals that contain titanium. It is used to make titanium metal and other titanium-containing compounds, such as titanium dioxide, which is used as a white pigment in paints and other products.
Titanium tetrachloride is very irritating to the eyes, skin, mucous membranes, and the lungs. Breathing in large amounts can injure the lungs seriously enough to cause death. There is no evidence that chronic exposure to titanium tetrachloride causes cancer in humans. The MCL and ACGIH TLV haven't been determined for this chemical. The NIOSH REL is set at 0.001 mg/m^3.

1,2,4-Trichlorobenzene
1,2,4-Trichlorobenzene is an experimental teratogen. This chemical is an irritant to the eyes, skin, and mucous membrane. Symptoms often affect the liver, kidney, and adrenal gland. The carcinogenicity of this chemical is unknown. The MCL is set at 0.07 mg/L. The ACGIH TLV is set at 5 ppm.

1,1,1-trichloroethane
1,1,1-trichloroethane is synthetic material that is also known as methyl chloroform. Symptoms often seen include: dizziness, conjunctiva irritation, hallucinations or distorted perceptions, motor activity changes, irritability, aggression, hypermotility, diarrhea, poor equilibrium, dermatitis, nausea or vomiting, cardiac arrhythmias, and other gastrointestinal changes. The IARC has determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV and NIOSH REL are set at 350 ppm.

Trichloroethylene (TCE)
TCE is also known as trichloroethylene. Symptoms of inhalation and ingestion are mildly toxic to humans and include: eye irritation, somnolence, hallucinations or distorted perceptions, gastrointestinal changes, and jaundice. Addiction results in those that work with the chemical. High-levels of exposure lead to headache and drowsiness, and eventual ventricular fibrillation resulting in cardiac failure, which in turn damages the liver and other organs. NIOSH has determined this chemical to be a potential occupational carcinogen; the recom-

mended REL is 2 ppm. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 50 ppm.

Tetrahydrofuran
Tetrahydrofuran, also known as tetramethylene oxide or THF, is a mildly toxic chemical. Symptoms often seen include: general anesthesia, irritant to eyes, mucous membranes, and upper respiratory system, narcotic in high concentrations, liver and kidney damage, and central nervous system depression. The NIOSH REL is set at 200 ppm.

Vinyl Chloride
Vinyl Chloride is moderately toxic by ingestion and a severe irritant to skin, eyes, and mucous membranes. High concentrations of vinyl chloride act as an anesthetic and chronic exposure can lead to liver injury. The carcinogenicity of vinyl chloride is confirmed in producing a rare cancer in the liver and blood tumors. The production of vinyl chloride is also a source of dioxins.[2] The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 5 ppm.

High Explosives Compounds

Explosives are chemical compounds or mixtures that are typically used in detonators in bombs. Large amounts of gas and heat are generated with the production of sudden pressure effects. As a result, the explosives vary in intensity and resistance. Mixing of chemicals produces varied effects and intensities upon explosion.

1,3-Dinitrobenzene
1,3-dinitrobenzene**,** also known as 2,4-dinitrobenzene, is a synthetic explosive formed as a by-product from the manufacturing of TNT. Mixing this chemical with tetranitromethane results in a high explosive that is very sensitive to sparks. No odor or taste is associated with this chemical. This chemical is slightly soluble in water and does not stick strongly to soil and as a result travels through the soil into the groundwater. Symptoms of exposure include headache, anoxia, cyanosis, visual disturbance, central scotomas, bad taste, burning mouth, dry throat, thirst, anemia, liver damage, nausea, and dizziness. Long-term exposure results in a reduction of the number of red blood cells. The carcinogenicity of this chemical is undetermined for humans. The NIOSH REL is set at 1 mg/m^3.

Dinitrotoluene (DNT)
Dinitrotoluene (DNT) is a poison that is carcinogenic with experimental tumorigenic and teratogenic data. Symptoms of exposure may include anozia, cyanosis, anemia, jaundice, and reproductive effects. The MCL has not been determined for this chemical but the ACGIH TLV is set at 1.5 mg/m^3. The NIOSH REL is set at 1.5 mg/m^3.

2,6-Dinitrotoluene
2,6-Dinitrotoluene is a synthetic explosive that is one of the six forms of chemicals of dinitrotoluene. This chemical is a pale yellow solid with a slight odor. Health effects from exposure to this chemical are uncertain. The nervous system and blood of exposed workers may be affected. The IARC has determined that this chemical is a potential carcinogen.

HMX
HMX, also known as cyclotetramethylene tetranitrate, is an acronym for High Melting Explosive. Other names for this chemical include: octogen and cyclotetramethylene-tetranitramine. It is a colorless solid that dissolves slightly in water with an unknown taste and smell. This chemical is made from other chemicals known as hexamine, ammonium nitrate, nitric acid, and acetic acid. The high volatility of this chemical enabled its use in explosives, rocket fuels, and burster chargers. No information is known on how you might be exposed to HMX in the environment and the information on adverse health effects is limited. The EPA has concluded that the carcinogenicity to humans is not classifiable. The MCL and ACGIH TLV have not been determined for this chemical.

4-Nitrotoluene
4-Nitrotoluene is a poison that is moderately toxic by ingestion. Contact with skin is mildly toxic. This chemical is combustible upon exposure to heat or flame. Symptoms of exposure may include anoxia, cyanosis, headache, weakness and exhaustion, dizziness, ataxia, difficulty breathing, tachycardia, nausea, and vomiting. When it is combined with tetranitromethane a very sensitive high explosive is created. The NIOSH REL is set at 11 mg/m^3.

4-PETN (Pentaerythritol Tetranitrate)
PETN, also known as Pentaerythritol Tetranitrate, is a hazardous chemical that explodes when shocked or exposed to heat. Ingestion

results in dermatitis. Other symptoms of exposure include: headaches, weakness, and fall in blood pressure. The MCL and ACGIH TLV have not been determined for this chemical.

4-Perchlorate

Perchlorate is synthetic and man-made. Perchlorates are incredibly unstable materials. Irritation to the body results in contact with any perchlorate. Mixtures of this chemical form explosives. This chemical affects the functioning of the thyroid gland. Alteration to thyroid gland functions can potentially lead to the formation of tumors.

4-RDX

RDX**,** otherwise known as Royal Demolition Explosive, is one of the most powerful high explosives in use today. Other names for this chemical include: cyclotrimethylene-trinitraminecyclonite, cyclonite, and 1,3,5-trinitro-1,3,5-triazine. As a synthetic, white powder, when RDX is burned fumes are created. This chemical is rarely used alone and is typically combined with other explosives, oils, or waxes. Symptoms of exposure to RDX include: seizures, nausea, headache, irritability, weakness and exhaustion, tremor, dizziness, insomnia, and vomiting. Knowledge of birth defects or affects on reproduction in humans is yet to be discovered. The carcinogenic properties of RDX are unknown. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1.5 mg/m^3. The NIOSH REL is set at 1.5 mg/m^3.

Tetryl

Tetryl is also known as nitramine and 2,4,6-trinitrophenyl-n-methylnitramine. This explosive is an extremely sensitive high explosive, more so than TNT to shock and friction. When combined on contact with trioxygen difluoride the chemical explodes on contact. This chemical is an irritant, sensitizer, and allergen. Symptoms of exposure may include sensitization dermatitis, redness, inflammation of the cornea, sneeing, anemia, cough, coryza, irritability, malaise, headache, weakness and exhaustion, insomnia, nausea, vomiting, and liver and kidney damage. The NIOSH REL is set at 1.5 mg/m^3.

2,4,6-Trinitrotoluene

2,4,6-Trinitrotoluene is an explosive commonly referred to as TNT. Ingestion results in hallucinations or distorted perceptions, cyanosis, and gastrointestinal changes. Contact with this chemical results in

skin irritation. Health effects include jaundice, cyanosis, sneezing, cough, sore throat, peripheral neuropathy, muscle pain, kidney damage, cataract, sensitization dermatitis, headaches, weakness, anemia, and liver injury. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Fuel Components and other Organic Chemicals

Toxic chemicals are known to disrupt normal bodily functions, including the functions of hormones. Hormones provide a number of services as natural chemicals to the human body including: act as messengers, travel through the blood stream, regulate various bodily processes, and coordinate the body's activities to maintain health through controlling growth, development, and behavior.[2]

Acenapthylene

Acenapthylene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters in all tissues that contain fat. Acenapthylene is stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that acenapthylene is a known animal carcinogen; however, the EPA has determined that the human carcinogenicity is not classifiable. The MCL and ACGIH TLV have not been determined for this chemical.

Acetone

Acetone is a colorless liquid with a distinct smell and taste that is naturally found in the environment as well as manufactured. Other names for this chemical include: dimethylketone, 2-propanone, and beta-ketopropane. In small amounts, the liver breaks acetone down into energy making chemicals used for normal body functions. Exposure results in entry of acetone into the blood stream and is subsequently carried to the rest of the organs. Inhalation of moderate-to-high amounts for even short periods of time can result in nose, throat, lung, and eye irritation, headaches, light-headedness, confusion, increased pulse rate, effects on blood, nausea, vomiting, unconsciousness and possibly coma, and the shortening of the menstrual cycle in women. Ingestion of small amounts typically does not cause harm. However, ingestion of high levels results in abdominal pain, nausea,

and vomiting. Effects of long-term exposure to acetone include kidney, liver, and nerve damage, increased birth defects, metabolic changes, and coma. The use of alcoholic beverages enhances the toxic effects of acetone. The US DHHS, the IARC, and the EPA have not classified acetone for carcinogenicity in humans. The MCL has not been determined for this chemical. The ACGIH TLV is set at 750 ppm. The NIOSH REL is set at 0.1 ppm.

Ammonia
Ammonia exposure symptoms often seen include: irritation to eyes and mucous membranes. Symptoms often seen include: breathing difficulty, wheezing, chest pain, pulmonary edema, skin burns, liquid, and frostbite. High-levels of exposure result in blindness, lung damage, heart attack, or death. The US DHHS, IARC, and the EPA have not classified the carcinogenicity of ammonia. The ACGIH TLV and NIOSH REL are set at 25 ppm.

Anthracene
Anthracene is a skin irritant and allergen. The carcinogenicity of this chemical is probable.

9,10-Anthracenedione
9,10-Anthracenedione, also known as anthraquinone, is a mild allergen.

Asbestos
Asbestos is comprised of six different minerals that are found in nature. This chemical enters the drinking water from natural sources in addition to corroded asbestos worn away from cement pipes. The separable, heat resistant fibers that make up the minerals are strong and flexible enough to be spun and woven. As a result, asbestos was widely used in building materials, friction products, heat resistant fabrics, packaging, gaskets, and coatings. Inhalation of lower levels of asbestos may result in changes called plaques in the linings. Long-term inhalation of asbestos fibers may result in scar-like tissue in the lungs and in the lining that surrounds the lung. Breathing difficulties, restricted pulmonary function, and heart enlargements arise as a result of exposure, eventually leading to disability and death. The US DHHS, the WHO, and the EPA have determined that asbestos is a human carcinogen and produces lung tumors. The MCL is set at 7 million fibers/L and the ACGIH TLV is set at 2 fibers/cubic centimeters.

Benzaldehyde
Benzaldehyde is an allergen. Symptoms often seen include: dermatitis, central nervous system depression, and anesthetic. The carcinogenicity of this chemical is probable.

Benzene
Benzene is a colorless liquid with a sweet odor that is formed from natural processes as well as human activities. With its wide distribution throughout the US, the uses of benzene are expansive, some of which include rubbers, lubricants, dyes, degreasers, detergents, drugs, pesticides, and as a major component of gasoline. This chemical enters the drinking water through leaking underground gasoline and petroleum tanks or improper waste disposal. Inhalation of high levels of benzene can result in drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, unconsciousness, and even death. Diseases that result from inhalation include Hodgkin's Disease and lymphomas. Ingestion of benzene is moderately toxic and is a severe eye and moderate skin irritant. Long-term exposure results in harmful effects on the bone marrow, leading to myeloid leukemia, as well as a decrease in red blood cells that leads to anemia. In addition excessive bleeding can occur and the immune system can be affected. Long-term exposure of workers to this chemical is linked to brain cancer and leukemia. Additionally, other possible health complications may arise in reproductive and developmental effects. The US DHHS has determined that benzene is a known human carcinogen. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 0.1 ppm.

n-Butanol
n-Butanol is also known as n-butyl alcohol. Symptoms often seen include: conjunctiva irritation, unspecified respiratory system and nasal effects, severe skin and eye irritant, corneal inflammation, slight headache and dizziness, slight irritation of the nose and throat, and dermatitis. The ACGIH TLV and NIOSH REL are set at 50 ppm.

Delta-BHC
Delta-BHC is also known as delta-benzenehexachloride and is a moderately toxic chemical.

Gamma BHC
Gamma BHC is also known as the gamma isomer of benzene hexachloride. Symptoms often seen include: irritation to the eyes skin, nose, and throat, headache, nausea, respiratory difficulty, convulsions, dyspnea, and cyanosis. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Benzo(a)anthracene
Benzo(a)anthracene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. This chemical is a poison by intravenous routes that is commonly an air contaminant of food, water, and smoke. The IARC and the EPA have determined it is a probable human carcinogen. The MCL and ACGIH TLV levels have not been determined.

Benzo(a)pyrene
Benzo(a)pyrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. This chemical is a poison via subcutaneous, intraperitoneal, and intrarenal routes that is commonly an air contaminant of food, water, and smoke. Experimental teratogenic and reproductive effects have been found. The IARC and the EPA have determined it is a probable human carcinogen. The MCL is set at 0.0002 mg/L and the ACGIH TLV has not been determined for this chemical.

Benzo(b)fluoranthene
Benzo(b)fluoranthene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC and the EPA have determined this chemical to be a possible human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Benzo(k)fluoranthene
Benzo(k)fluoranthene is a known carcinogen.

Benzo(g,h,i)perylene
Benzo(g,h,i)perylene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC and the EPA have determined this chemical not classifiable as to the carcinogenicity to humans. The MCL and ACGIH TLV have not been determined for this chemical.

Benzoic Acid
Benzoic Acid is found naturally in resins and manufactured synthetically. It is a colorless crystalline solid and is used as a food preservative and in pharmaceuticals and cosmetics. Inhalation affects the human nervous system, dypsnea, and allergic dermatitis. This chemical is a poison by subcutaneous route and is moderately toxic by ingestion and intraperitoneal routes. In addition, it is a severe eye and skin irritant. The MCL and ACGIH TLV have not been determined for this chemical.

Bis-(2-ethylhexyl)phthalate
Bis-(2-ethylhexyl)phthalate, also known as di-sec-octyl phthalate, is a poison upon entry into the blood stream. Ingestion affects the gastrointestinal tract. In addition, this chemical is a mild skin and eye irritant and can cause liver damage. This chemical is a confirmed carcinogen with experimental carcinogenic and tumorigenic data. The MCL is set at 0.006 mg/L and the ACGIH TLV is set at 5 mg/m^3. The NIOSH REL is set at 5 mg/m^3.

Carbazole
Carbazole is a pesticide poisonous by intraperitoneal routes. Ingestion is moderately toxic. It is a questionable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Carbon disulfide
Carbon disulfide is found naturally as well as a commercially made chemical. Symptoms often seen include: narcotic and anesthetic ef-

fects to the central nervous system, dizziness, headache, poor sleep, anorexia, weight loss, Parkinson-like syndrome, coronary heart disease, gastritis, kidney, liver injury, eye and skin burns, respiratory failure, and even death. The US DHHS, the IARC, and the EPA have not determined the carcinogenicity of this chemical. The ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 1 ppm.

Chrysene
Chrysene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC has determined the carcinogenicity is not classifiable for humans. The EPA has determined that this chemical is a probable human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Cyclohexane
Cyclohexane is also known as benzene hexahydride and hexahydrobenzene. Symptoms often seen include: irritation to eyes, skin, and respiratory system, drowsiness, dermatitis, narcosis, and coma. The ACGIH TLV and NIOSH REL is set at 300 ppm.

Cyclohexanone
Cyclohexanone is a severe eye irritant. Symptoms often seen include: changes in the sense of smell, headache, narcosis, coma, dermatitis, conjunctiva irritation, and unspecified respiratory system changes, mild narcotic, and a skin and eye irritant. The ACGIH TLV and NIOSH REL are set at 25 ppm.

Dibenz(a,h)anthracene
Dibenz(a,h)anthracene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that this chemical is a known animal carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Di-n-octylphthalate
Di-n-octylphthalate is also known as di-sec-octylphthalate. This chemical affects the gastrointestinal tract, central nervous system, liver, reproductive system, and gastrointestinal tract. This chemical is also a mild skin and eye irritant. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 5 mg/m^3.

1,2-Diphenylhydrazine
1,2-Diphenylhydrazine, also known as Hydrazobenzene, is a white solid with no information on smell or flammability. This manufactured chemical does not dissolve easily in water and when placed in water it rapidly breaks down into other toxic chemicals. This chemical is currently used in medicines to treat inflammation and a type of arthritis. Effects of ingestion lead to chemical poisoning. Diphenylhydrazine is a confirmed carcinogen with experimental carcinogenic and tumorigenic data. Poison by ingestion. The MCL and ACGIH TLV have not been determined for this chemical.

Ethyl Acetate
Ethyl Acetate is a chemical that can cause dermatitis. Inhalation results in severe irritation to mucous membranes and upper respiratory tract, poisoning, human systemic effects such as olfactory changes, conjunctiva irritation, and pulmonary changes. Ingestion of this chemical is mildly toxic in causing irritation to the gastrointestinal tract with symptoms such as nausea, vomiting, and diarrhea. Long-term exposure yields conjunctival irritation and corneal clouding, congestion of the liver and kidneys. High concentrations have a narcotic effect in addition to resultant liver and kidney damage. Chronic poisoning may lead to anemia with leukocytosis (a transient increase in the white blood cell count), cloudy swelling, and fatty degeneration of the viscera. The MCL has not been determined for this chemical and the ACGIH TLV is set at 400 ppm. The NIOSH REL is set at 400 ppm.

Ethylbenzene
Ethylbenzene is a moderately toxic chemical. Symptoms often seen include: eye, sleep, and pulmonary changes, eye and skin irritation, headache, dermatitis, narcosis, coma, dizziness, irritation of the nose and throat, and a sense of constriction in the chest. The ACGIH TLV and NIOSH REL are set at 100 ppm.

Fluoranthene
Fluoranthene is a moderately toxic chemical. The carcinogenicity is probable.

n-Hexane
n-Hexane is a slightly toxic chemical made from crude oil. Symptoms often seen include: irritation to the eyes, skin, respiratory system, central nervous system, and peripheral nervous system, paralysis, and hallucinations. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of this chemical. The ACGIH TLV and NIOSH REL are set at 50 ppm.

2-Hexanone
2-Hexanone is also known as Butyl methyl ketone or Methyl butyl ketone. This chemical is moderately toxic. Symptoms often seen include: irritation to the eyes and nose, peripheral neuropathy, weakness, exhaustion, paresthesia, vomiting, dermatitis, headache, and drowsiness. This chemical is a skin and eye irritant. The ACGIH TLV is set at 5 ppm. The NIOSH REL is set at 1 ppm.

Indeno(1,2,3-c,d)pyrene
Indeno(1,2,3-c,d)pyrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The IARC has determined this chemical to be a possible human carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Methyl Ethyl Ketone (MEK)
Methyl Ethyl Ketone (MEK) is a strong irritant that affects the peripheral nervous system and central nervous systems. Effects of inhalation at low-levels of exposure result in human systemic effects, including conjunctiva irritation and effects on the nose and respiratory system. Inhalation at high levels results in headaches, dizziness, nausea, shortness of breath, and vomiting, in addition to central nervous system depression and unconsciousness. Effects of ingestion result in abdominal pain and nausea. Contact by skin results in redness, itching, and pains; long-term exposure results in dermatitis. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 200 ppm. The NIOSH REL is set at 200 ppm.

Methyl methacrylate
Methyl methacrylate is a moderately toxic chemical. Symptoms often seen include: sleep effects, excitement, anorexia, and blood pressure decrease. This chemical is a severe skin, eye, nose, and throat irritant. The ACGIH TLV and NIOSH REL are set at 100 ppm.

2-Methylnapthalene
2-Methylnapthalene is a white solid that is found naturally in fossil fuels. High-levels of exposure damages red blood cells. Symptoms of acute poisoning include: fatigue, lack of appetite, restlessness, and pale skin. Symptoms of a higher exposure include: nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of this chemical. The MCL and ACGIH TLV have not been determined for this chemical.

Nitrates
Nitrates ingested in large amounts can result in death. Symptoms often seen include: dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions, collapse, and even mental impairment. The carcinogenicity of this chemical is probable.

Nitrobenzene
Nitrobenzene is an industrial chemical typically used to manufacture aniline. Symptoms often seen include: general anesthetic, anoxia, dermatitis, anemia, respiratory stimulation, and vascular changes. This chemical is also an eye and skin irritant and is absorbed readily through the skin. The IARC has determined this chemical to be a probable carcinogen. The ACGIH TLV and NIOSH REL are set at 1 ppm.

N-nitrosodi-n-propylamine
N-nitrosodi-n-propylamine is a manufactured chemical for use in research and as a weed killer. The effect on humans remains unknown for this chemical. The US DHHS has determined that n-nitrosodi-n-propylamine is a probable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

Octadecanoic acid
Octadecanoic acid is also known as stearic acid. This chemical is a skin irritant. The carcinogenicity of this chemical is probable.

Pentachlorophenol (PCP)
Pentachlorophenol (PCP) occurs as a colorless crystal. The smell varies with the temperature of this manufactured chemical. Uses of this chemical include use as a biocide and wood preservative. Symptoms of exposure may include sneezing, cough, weakness and exhaustion, anorexia, weight loss, sweating, headache, dizziness, nausea, vomiting, dyspnea, chest pain, high fever, and damage to the liver, kidneys, blood, lungs, nervous system, immune system, and gastrointestinal tract. Contact with skin and eyes cause dermatitis and irritation. The IARC has determined that this chemical is a possible carcinogen to humans. The MCL is set at 0.001 mg/L and the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Pheneanthrene
Pheneanthrene is a Polycyclic Aromatic Hydrocarbon (PAH). The presence of this chemical arises from the use of fuel components and other organic chemicals. This chemical is a danger to humans and enters all tissues that contain fat. PAHs are stored mostly in the kidneys, liver, and fat with smaller amounts stored in the spleen, adrenal glands, and ovaries. The US DHHS has determined that pheneanthrene is a known animal carcinogen; however, the EPA has determined not classifiable to human carcinogenicity. The MCL and ACGIH TLV have not been determined for this chemical.

PCBs
PCBs are also known as polychlorinated biphenyls. Of the 109 PCBs, many affect hormones and are linked with brain cancer. This chemical is moderately toxic by ingestion and skin contact. The carcinogenicity of this chemical is probable. The MCL is set at 0.0005 mg/L, but the ACGIH TLV has not been determined for this chemical.

Pyrene
Pyrene is a poison through inhalation. This chemical is a skin irritant. The carcinogenicity of this chemical is probable.

Sulfates
Sulfates are elements combined with both sulfur and oxygen. These materials vary in toxicity.

Toluene
Toluene is a poison to humans via various routes. Inhalation, intravenous and subcutaneous routes prove to be mildly toxic. Effects of inhalation result in hallucinations, distorted perceptions, motor activity changes, antipsychotic, pyschophysiological test changes, and bone marrow changes. Other Symptoms of exposure may include irritation to nose and eyes, weakness and exhaustion, confusion, dizziness, headache, anxiety, muscle fatigue, insomnia, paresthesia, dermatitis, and liver and kidney damage. This chemical is an irritant to the eyes and skin and is linked to brain cancer. The MCL is set at 1 mg/L and the ACGIH TLV is set at 100 ppm. The NIOSH REL is set at 100 ppm.

1,3,5-Trinitrobenzene
1,3,5-Trinitrobenzene is a powerful explosive that has more power for shattering than TNT, but less sensitive to impact. This chemical is difficult to produce. Ingestion has proven moderately toxic. The MCL and ACGIH TLV have not been determined for this chemical.

Metals

Metals are found naturally in the environment and tend to remain for a long time, thereby increasing a greater likelihood for exposure. Some metals are useful in small amounts and even necessary for good health. Metals can accumulate in vegetables, grains, fruits, fish, and shellfish from surrounding soil and water. Health effects caused by heavy metals include reduced growth and development, cancer, and organ damage, which can lead to autoimmunity, rheumatoid arthritis, and diseases of the kidneys, circulatory system, and nervous system. Metals have a greater effect on children and exposure can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems.[3]

Aluminum
Aluminum occurs naturally and makes up about 8% of the surface of the earth. It is always found combined with other elements such as oxygen, silicon and fluorine. This metal is silver-white and flexible. Uses primarily include cooking utensils, containers, appliances, build-

ing materials, paints, fireworks, glass, rubber, ceramics and consumers products such as antacids, astringents, buffered aspirins, food additives and antiperspirants. Low-level exposure to aluminum from food, air, water, or contact with skin is not thought to harm your health. Aluminum, however, is not a necessary substance for our bodies and too much may be harmful. People who are exposed to high levels of aluminum may have respiratory problems, bone diseases and skeletal problems, skin rashes and delays in neurological development. The Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have not classified aluminum for carcinogenicity. The SMLC is set at 0.05-0.2 mg/L. Both ACGIH and NIOSH have established guidelines values from 2 mg/m^3 for soluble salts to 10 mg/m^3 for aluminum for total dust.

Antimony

Antimony is a silvery-white, corrosive metal found naturally in the earth's crust. Typically, antimony is brought into the United States for processing, mixed with alloys for strength, and used in the flame retardant industry. Other uses of this chemical include: ceramics, glass, batteries, fireworks, and explosives. Antimony enters the drinking water through natural weathering of rock, industrial production, municipal waste disposal or manufacturing processes. Inhalation of high-levels will result in lung problems. Ingestion of high-levels of antimony will result in heart problems, stomach pain, diarrhea, vomiting, and stomach ulcers; other unknown effects may result from ingestion. Contact with this chemical results in irritation and burns. Medicinal uses of antimony exist in treating people infected with parasites. The US DHHS, the IARC, and the EPA have not classified antimony as to its human carcinogenicity. The MCL is set at 0.006 mg/L and the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine and sulfur to form inorganic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds. It is mainly used to preserve wood. Its use in pesticides has been canceled or restricted.

It cannot be destroyed in the environment; it can only change its form. Organic arsenic compounds are less toxic than inorganic arsenic compounds.

Arsenic was listed as the most dangerous substance in the Top 20 hazardous substances on the CERCLA priority List of Hazardous Substances for 2001.

Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white cells, abnormal heart rhythm, damage to blood vessels, darkening of the skin, and a sensation of "pins and needles" in hand and feet. Arsenic is a human carcinogen and can notably increase the risk of cancer in the lung, skin, bladder, liver, kidney and prostate. The MLC is set at 0.05 mg/L, the ACGIH TLV at 0.5 mg/m^3, and the NIOSH REL at 0.002 mg/m^3. The WHO has established a provisional guideline value of 0.01 mg/L for arsenic in drinking water.

Barium

Barium is a silvery-white metal found in nature and can be produced synthetically. This chemical is typically found in compounds combined with sulfur, carbon, or oxygen and enters the drinking water after dissolving from naturally occurring minerals in the ground. Uses of barium include: oil and gas drilling muds, auto paint, bricks, tiles and jet fuels. The effect on a person's health is greatly dependent on how well the compound dissolves in water. Compounds that do not dissolve well in water are not generally harmful and are often used for medicinal purposes. Ingestion of high-levels result in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, brain swelling, muscle weakness, damage to the liver, kidney, heart, and spleen. Symptoms of barium contamination include vomiting, colic, diarrhea, slow irregular pulse, transient hypertension, and convulsive tremors and muscular paralysis. Death may occur in a few hours to a few days. The US DHHS, the IARC, and the EPA have not classified barium as to its human carcinogenicity. The MCL is set at 2 mg/L and the ACGIH TLV is set at 0.5 mg/m^3.

Beryllium

Beryllium in its pure form is a hard, grayish metal with no particular smell. Naturally, it can be found in compounds within mineral rocks, coal, soil, and volcanic dust and enters the drinking water from runoff from mining operations, discharge from processing plants and improper waste disposal. This chemical is often used in electrical equipment and electrical components. Effects of inhalation depend on exposure possibly causing lung damage and a disease resembling pneumonia leading to death. Ingestion of beryllium is not known to

cause effects in humans due to the restriction of movement from the stomach and intestines into the bloodstream. However, it is a deadly poison by intravenous routes. Rashes or ulcers arise from direct contact. The US DHHS has determined that this chemical is a probable human carcinogen. The MCL is set at 0.004 mg/L and the ACGIH TLV is set at 0.002 mg/m^3. The NIOSH REL is set at 0.0005 mg/m^3.

Bismuth

Bismuth is poisonous to humans. Symptoms often seen include: kidney damage, malaise, albuminuria, diarrhea, skin reactions, exodermatitis, and even death

Boron

Boron is an incredibly toxic material. Symptoms often seen include: irritation of the nose, throat, and eyes, depression of the circulation, persistent vomiting and diarrhea, shock, coma, and even death. Ingestion of large amounts may damage the stomach, intestines, liver, kidney, and brain. Health effects for long-term exposure are not known. The US DHHS, the IARC, and the EPA have not classified the carcinogenicity of boron.

Cadmium

Cadmium is found naturally in the crust, typically as a mineral combined with other elements. This chemical does not corrode easily and is used in batteries, pigments, metal coatings, and plastics. Inhalation of high levels of cadmium will severely damage the lungs and can lead to death. Ingestion of high levels of cadmium irritates the stomach, leading to vomiting and diarrhea. Cadmium will build up in the kidneys, cause damage to the lungs, and creates fragile bones through long-term exposure to lower levels of cadmium. Skin contact with cadmium is not known to cause health effects in humans or animals. Beneficial effects of cadmium are unknown. The US DHHS has determined cadmium and cadmium compounds are probable carcinogens. The MCL is set at 0.005 mg/L and the ACGIH TLV is set at 0.005 mg/m^3.

Chromium

Chromium occurs naturally in the ground with no taste or smell associated with this element. This element is found in a few different forms, namely chromium (III) as an essential nutrient and chromium (VI) and chromium (0) typically produced industrially for use in electroplating of metals. Runoff from old mining operations and improper

waste disposal are the modes in which chromium typically enters the groundwater. Inhalation of high-levels of chromium (VI) causes irritations to the nose, such as runny nose, nosebleeds, ulcers, and holes in the nasal septum. Ingestion of high-levels of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact also results in skin ulcers. Other symptoms to exposure include severe redness and swelling of the skin in addition to an increased risk of lung cancer. The World Health Organization has determined that chromium (VI) is a human carcinogen. The MCL is set at 0.1 mg/L and the ACGIH TLV is set at 0.5 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Cobalt

Cobalt is a naturally occurring metal that may cause dermatitis or pulmonary damage. This metal is important to human health as a part of vitamin B12 and used to treat anemia. However, high levels of exposure severely affect the lungs. Symptoms often seen from inhalation include: cough, breathing difficulty, wheezing, decreased pulmonary function, weight loss, dermatitis, respiratory hypersensitivity, and asthma. Ingestion of soluble salts produces nausea and vomiting. The IARC has determined that cobalt is a probable carcinogen. The ACGIH TLV and NIOSH REL are set at 0.05 mg/m^3.

Copper

Copper is an essential element for all living things. This metal is also a potentially explosive chemical. Liquid copper explodes on contact with water. Symptoms often seen include: nausea and vomiting, diarrhea, stomach cramps, irritation to the eyes and respiratory system, cough, difficulty breathing, and wheezing. The IARC has determined the carcinogenicity of this chemical is unknown. The ACGIH TLV and NIOSH REL are set at 1 mg/m^3.

Fluoride

Fluoride is a pale, yellow-green gas that has a strong sharp odor. Fluorides are found throughout the environment at very low levels. Inhalation of high-levels of hydrogen fluoride gas causes damage to the lungs and heart and can even lead to death. Low-levels of hydrogen fluoride gas can irritate the eyes, skin, and lungs. Low-levels of sodium fluoride do help reduce tooth cavities, while high levels of sodium fluoride are dangerous to one's health. The carcinogenicity of fluoride has not been determined. The MCL is set at 4 mg/L, but the ACGIH TLV has not been determined.

Lead

Lead naturally occurs in the crust and is found throughout the environment. This element is used for many purposes and can affect nearly every organ and system of the body. It typically enters the drinking water supply through contact of water with corroded materials containing lead. The effects of inhalation and ingestion are the same; however, the major systems affected by lead poisoning include the nervous system, blood system, and kidneys. Symptoms of lead poisoning include: decreased reaction time, muscle weakness, loss of appetite, anemia, malaise, insomnia, headache, irritability, muscle and joint pains, tremors, flaccid paralysis without anesthesia, hallucinations, and distorted perceptions. Lead poisoning greatly diminishes the intellectual capacity of children, creates delays in normal physical and mental development in babies and young children, and slight deficits in attention span. The US DHHS has determined that more information is needed to determine the carcinogenicity in humans. The MCL has not been determined for this chemical, but the ACGIH TLV has been set at 0.15 mg/m^3. The NIOSH REL is set at 0.05 mg/m^3.

Manganese

Manganese is a naturally occurring metal that is critical to human health in trace amounts. This chemical reacts violently with certain compounds. Symptoms often seen include: degenerative brain changes, change in motor activity, muscle weakness, insomnia, mental confusion, metal fume fever, dry throat, cough, chest tightness, breathing difficulty, vomiting, malaise, kidney damage, and a skin and eye irritant. The carcinogenicity of this chemical is probable. High levels of exposure include: mental and emotional disturbances and slow and clumsy body movements. The EPA has determined the carcinogenicity to be unclassifiable. The ACGIH TLV is set at 5 mg/m^3. The NIOSH REL is set at 1 mg/m^3.

Mercury

Mercury occurs naturally in the environment occupying several forms. The nervous system is greatly affected by this element. High-levels of exposure can lead to permanent damage of the brain, kidneys, and developing fetus. Other limited effects of long-term effects result in irritability, shyness, and tremors, changes in vision or hearing and memory problems. This chemical is corrosive to skin, eyes, and mucous membranes. Symptoms of exposure may include gastrointes-

tinal disturbance, muscle weakness, anorexia, weight loss, headache, tinnitus, hypermotility, diarrhea, liver changes, dermatitis, and fevers. Mercury builds up in the tissues of fish and can then be ingested by humans. The carcinogenic effect of all forms of mercury is unknown. However, the EPA has determined that mercuric chloride and methylmercury are possible human carcinogens. The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 0.05 mg/m^3. The NIOSH REL is set at 0.05 mg/m^3.

Molybdenum

Molybdenum is a poison and an experimental teratogen. Symptoms often seen in animals include: irritation to the eyes, nose, and throat, anorexia, diarrhea, weight loss, listlessness, liver, and kidney damage. This chemical reacts violently with oxidants. The ACGIH TLV is set at 5 mg/m^3.

Nickel

Nickel is an abundant, hard, silvery-white metal found in nature with no characteristic odor or taste. Uses for nickel are expansive and include plating, jewelry, and as catalysts for chemical reactions. Small amounts of nickel are possibly essential to human life. Contact to skin may include allergic contact dermatitis, pulmonary asthma, conjunctivitis, and inflammatory reactions. Inhalation of high-levels of nickel affects the lungs, including chronic bronchitis and reduced lung function. Ingestion of high-levels of nickel affects the stomach, blood, and kidneys. The US DHHS has determined that nickel is a probable carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1 mg/m^3. The NIOSH REL is set at 0.015 mg/m^3.

Potassium

Potassium is an essential dietary element. This chemical is a dangerous fire hazard. Ingestion of excessive amounts results in kidney failure, nausea, vomiting, abdominal discomfort, diarrhea, heart arrhythmia leading to cardiac arrest., muscular weakness, and temporary paralysis.

Selenium

Selenium is found in the environment in rocks and soil. Inhalation of selenium can result in soreness, coughing, labored breathing, and lung edema. Symptoms of exposure to high-levels include: dizziness, fatigue, irritation, collection of fluid in the lungs, and severe bronchi-

tis. Ingestion of high-levels could result in irritation to the mouth and throat, in addition to nausea, gastrointestinal disturbance, and vomiting. Other results of exposure include brittle hair, anemia, cirrhosis, deformed nails, and even death. Contact with skin results in rashes, swelling, and pain. Chronic exposure might result in pallor, nervousness, depression, garlic odor of breath and sweat, gastrointestinal disturbances, and dermatitis. The US DHHS has declared that selenium sulfide is a probable carcinogen. The EPA has declared that the carcinogenicity of selenium compounds is not classifiable. The MCL is set at 0.05 mg/L and the ACGIH TLV is set at 0.2 mg/m^3. The NIOSH REL is set at 0.2 mg/m^3.

Silver

Silver occurs naturally and is typically found in the environment combined with other elements. Uses primarily include jewelry, brazing alloys and solders, disinfectant of drinking water and water in swimming pools, and as an antibacterial agent. Inhalation of high-levels may lead to lung and throat irritation, and stomach pains. Ingestion of high-levels may result in death. Skin contact may result in a rash, swelling, and inflammation. Exposure at low-levels may result in the deposition of silver into the skin. Long-term exposure at high-levels may lead to arygria, a discoloration of the skin and other body tissues. The carcinogenicity of silver is unknown for humans. The MCL is not determined for this chemical, but the ACGIH TLV is set at 0.1 mg/m^3. The NIOSH REL is set at 0.1 mg/m^3.

Tin

Tin is a natural element in the earth's crust. It is a soft, white, silvery metal that doesn't dissolve in water, Tin is used mainly to make cans. The EPA has limited its use in paints. Large amounts of tin compounds can cause stomachaches, anemia, liver and kidney problems. Breathing or swallowing this chemical can cause breathing problem, eye irritation, and can interfere with the way your brain and nervous system work. In severe cases, it can cause death.

There is no evidence that tin or tin compounds cause cancer in humans or animals, and tin hasn't been classified for carcinogenicity. The MLC hasn't been determined for this chemical. Both the ACGIH TLV and the NIOSH REL are set at 2 mg/m^3.

Thallium

Thallium is a radionuclide found in nature. Ingestion of this chemical results in nerve or sheath structural changes, extra-ocular muscle

changes, sweating, and other effects. The MCL is set at 0.002 mg/L and the ACGIH TLV is set at 0.1 mg/m^3.

Vanadium
Vanadium has a variable toxicity. Exposure to this chemical results in conjunctivities, rhinitis, reversible irritationism of the respiratory tract, bronchitis, bronchospasms, and asthma-like diseases in more severe cases. The MCL and ACGIH TLV have not been determined for this chemical.

Zinc
Zinc is a skin irritant. Symptoms often seen include: cough, dyspnea, sweating, throat dryness, sweet taste in mouth, cough, weakness, aches, chills, fever, nausea, and vomiting.

Pesticides

After the publication of Rachel Carson's book *Silent Spring* in 1962, concern arose for the use of chemical pesticides entering the food chain. Pesticides are toxic to living organisms and yet little is known about the extent of health effects on humans. Despite the obvious benefit to eradicating disease-carrying and crop-eating insects, the behavior of such chemicals is not completely understood. It is known that pesticides accumulate in fat deposits in the body. A mode of excretion occurs through breast milk, thereby transferring the harmful chemicals ingested from mother to child. Pesticides greatly affect the developing fetus, infants and young children. Health effects resulting from exposure cause serious diseases and disorders, damage to the nervous system, reproductive system and other organs, developmental and behavioral abnormalities, disruption of normal hormonal function, and immune dysfunction.

Acrylonitrile
Acrylonitrile is synthetic material used to make other chemicals. In the past, acrylonitrile was combined with carbon tetrachloride for use as a pesticide. Symptoms often seen include: conjunctive irritation, somnolence, general anesthesia, cyanosis, diarrhea, increased salivation, photophobia, deepened respiration, nausea, vomiting, weakness, headache, jaundice, anemia, nose and eye irritant, and leucocytosis. The effect that this chemical has on the human body in-

hibits respiratory enzymes of tissue and renders the tissue cells incapable of oxygen absorption. This chemical is carcinogenic. The US DHHS has determined that acrylonitrile is a probable carcinogen. The ACGIH TLV is set at 2 ppm. The NIOSH REL is set at 1 ppm.

Aldrin and Dieldrin

Aldrin and Dieldrin are chemicals that are similar in nature and in effect on humans. In pure form, both are white powders with a mild chemical odor and do not occur naturally in the environment. Aldrin quickly breaks down into dieldrin in the body and in the environment. By 1987 all uses of these chemicals were banned, including the use as a pesticide and for termite control. These chemicals mainly affect the central nervous system. Ingestion of significantly high-levels of these chemicals results in buildup, convulsions, coma and even death. The effects of low-levels of exposure include headaches, dizziness, vomiting, irritability, uncontrolled muscle movements. The IARC has determined that both aldrin and dieldrin are not classifiable as to their carcinogenicity to humans. The MCL has not been determined for these chemicals. The ACGIH TLV and NIOSH REL for both aldrin and dieldrin is set at 0.25 mg/m^3.

Alpha BHC

Alpha BHC, also known as Benzene Hexachloride-alpha-isomer, is a poison by ingestion. This chemical is a confirmed carcinogen with experimental carcinogenic, tumorigenic, and neoplastigenic data. The MCL and ACGIH TLV have not been determined for this chemical.

Beta BHC

Beta BHC is also known as trans-alpha-benzenehexachloride. This chemical is a confirmed carcinogen with experimental neoplastigenic data. Ingestion of Beta BHC is mildly toxic. The MCL and ACGIH TLV have not been determined for this chemical.

Chlordane

Chlordane is a thick liquid whose color ranges from colorless to amber with a mild and irritating smell that was manufactured for use as a pesticide. Uses of this chemical were completely banned in 1988 by the EPA. Although chlordane is not very mobile in soils, it is known to enter the drinking water after application on crops near the water supply intakes or well. Exposure to this chemical affects the nervous system, digestive system, and the liver. It has been found that chlordane lacks the ability to disrupt hormones by itself but greatly

magnifies the ability of other chemicals to disrupt hormones. Inhalation of high-levels of chlordane include: headaches, irritability, confusion, weakness, vision problems, vomiting, stomach cramps, diarrhea, and jaundice have occurred in people who breathed air containing high concentrations of chlordane or accidentally swallowed small amounts of chlordane. Ingestion of high-levels leads to convulsions and death. The IARC has determined that chlordane is not classifiable as to its carcinogenicity to humans. The MCL is set at 0.002 mg/L and the ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

DDD

DDD, also known as 1,1-bis(4-chlorophenyl)-2,2-di-chloroethane, was once used as a pesticide. Uses for this chemical have been banned. This chemical contaminates DDT products and DDT typically breaks down into DDE or DDD. The nervous system is greatly affected. Symptoms often seen include: excitability, tremors, and seizures. Ingestion results in poisoning. The US DHHS has not determined the carcinogenicity for DDD. This pesticide is a known carcinogen.

DDE

DDE, also known as 2,2-Bis(p-Chlorophenyl)-1,1-Di-Chloroethylene, sometimes is a contaminant for DDT products with no commercial use. The US DHHS has not classified DDE as to the carcinogenicity to humans. The EPA has determined that this chemical is a probable carcinogen. The MCL and ACGIH TLV have not been determined for this chemical.

DDT

DDT, also called 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane, is a manufactured chemical used as a pesticide. This chemical is a white, crystalline solid with no odor or taste. The use of this chemical was banned in the United States, aside from public health emergencies. Symptoms of exposure may include irritation to the eyes and skin, anxiety, dizziness, confusion, discomfort, headache, weakness and exhaustion, convulsions, vomiting, excitability, tremors, and seizures. Long-term exposure to this chemical affects the nervous system and results in changes in the levels of liver enzymes. The US DHHS has determined that this chemical is a probable human carcinogen. The MCL has not been determined for this chemical, but the ACGIH TLV is set at 1 mg/m^3. The NIOSH REL is set at 0.5 mg/m^3.

Di-n-butyl phthalate
Di-n-butyl phthalate exposure symptoms often seen include: eye, stomach, and upper respiratory irritation, hallucinations, distorted perceptions, nausea or vomiting, and kidney, ureter or bladder changes. The ACGIH TLV and NIOSH REL are set at 5 mg/m^3.

Dicamba
Dicamba, also known as 2-Methoxy-3,6-Dichlorobenzoic Acid, is moderately toxic by ingestion. The MCL and ACGIH TLV have not been determined for this chemical.

1,2-Dichloroethane
1,2-Dichloroethane, also known as ethylene dichloride, is a synthetic chemical that is used to make other chemicals. Symptoms often seen include: somnolence, cough, jaundice, nausea or vomiting, hypermotility, diarrhea, ulceration or bellding from the stomach, fatty liver degeneration, change in cardiac rate, cyanosis, coma, dermatitis, edema of the lungs, toxic effects on the kidneys, and severe corneal effects. The US DHHS, the IARC and the EPA have not classified the carcinogenicity of this chemical. The ACGIH TLV is set at 10 ppm. The NIOSH REL is set at 1 ppm.

Dinoseb
Dinoseb, also known as 2-sec-Butyl-4,6-dinitrophenol, is a widely used herbicide. This chemical enters the drinking water after application on orchards, vineyards, and other crops. This chemical is a poison by ingestion and a severe irritant to the eyes. Pathways the chemical may travel into the body include: skin contact, subcutaneous, and intraperitoneal routes. The carcinogenicity is questionable with experimental tumorigenic data. The MCL is set at 0.007 mg/L for the chemical, while the ACGIH TLV has not been determined.

Endosulfan II
Endosulfan II is a pesticide and wood preservative found in solid form as crystals or flakes. This chemical smells similar to turpentine and does not burn. This chemical affects the central nervous system but does not accumulate significantly in human tissue. Symptoms of exposure may include irritation to the skin, hyperactivity, nausea, dizziness, headache, tremors, or convulsions, and even death may occur. The carcinogenicity of this chemical is unknown. The MCL has not been determined for this chemical, but the ACGIH TLV and NIOSH REL are set at 0.1 mg/m^3.

Endothall
Endothall is a poison extremely irritating to skin, eyes, and mucus membranes. Symptoms often include: diarrhea.

Endrin
Endrin is a pesticide that is a solid, white, almost odorless substance that is banned from use in the United States. This chemical accumulates in sediments and aquatic and terrestrial biota. Exposure to endrin can cause various harmful effects including death and severe central nervous system (brain and spinal cord) injury. Ingestion of this chemical may cause convulsions and will kill you in a matter of minutes to a matter of hours. This chemical does not accumulate in human tissue. Symptoms resulting from exposure include headaches, dizziness, nervousness, confusion, nausea, vomiting, and convulsions. Effects of inhalation or contact are not known. The EPA has declared the human carcinogenicity to be unknown. The MCL is set at 0.002 mg/L and the ACGIH TLV and NIOSH REL are set at 0.1 mg/m^3.

Gamma-chlordane
Gamma-chlordane is no longer permitted for use as a termiticide or pesticide. Symptoms often seen include: tremors, convulsions, excitement, diarrhea, jaundice, vomiting, stomach cramps, vision problems, ataxia, central nervous system stimulant, and gastritis. The IARC has not determined the carcinogenicity of this chemical. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Heptachlor and Heptachlor Epoxide (Epoxyheptachloris)
Heptachlor and Heptachlor Epoxide (Epoxyheptachloris) are manufactured chemicals found as a white powder that smell like camphor (mothballs). Heptachlor breaks down into heptachlor epoxide. These chemicals were used primarily as insecticides until 1988. Ingestion of heptachlor results in dizziness, confusion, or convulsions. The full extent of heptachlor and heptachlor epoxide poisoning are unknown for humans, other than damage to the nervous system. Low-levels of exposure have caused liver damage and the symptoms include tremors, convulsions, kidney damage, respiratory collapse, and death. The IARC has determined that heptachlor and heptachlor epoxide are not classifiable to their carcinogenicity to humans. The MCL for heptachlor is set at 0.0004 mg/L and the MCL for heptachlor epoxide is set at 0.0002 mg/L. The ACGIH TLV has not been determined for these chemicals. The NIOSH REL is set at 0.5 mg/m^3.

Heptachlorinated dibenzo-p-dioxins
Heptachlorinated dibenzo-p-dioxins is a type of dioxin. Dioxins are understood to function in a similar manner as a steroid hormone. This implies that the dioxins enter the body and bind to a protein. A complex is then formed that attaches to the cell's chromosomes, thereby altering the genetic material and affecting the body in many different ways. The MCL and ACGIH TLV have not been determined for these chemicals.

Isopropanol
Isopropanol is also known as Isopropyl alcohol and is a moderately toxic chemical. Symptoms often seen include: flushing, pulse rate decrease, blood pressure lowering, anesthesia, narcosis, headache, dizziness, mental depression, drowsiness, hallucinations, distorted perceptions, dyspnea, respiratory depression, nausea or vomiting, and coma. The ACGIH TLV and NIOSH REL are set at 400 ppm.

Lindane
Lindane, also known as benzene hexachloride, is a pesticide that mimics natural hormones. Under favorable soil and climatic conditions, lindane enters the drinking water through runoff of contaminated materials into surface water or by leaching into the groundwater. Inhalation results human systemic effects by headache, nausea or vomiting, and fever. Pathways taken by this chemical into the body include: ingestion, skin contact, and subcutaneous routes. This chemical is more toxic than DDT or dieldrin and is shown to damage the nervous system and circulatory system. Lindane is a confirmed carcinogen with experimental carcinogenic, neoplastigenic, and tumorigenic data by ingestion and skin contact. The MCL is set at 0.0002 mg/L, but the ACGIH TLV has not been determined for this chemical.

Methylene chloride
Methylene chloride is a synthetic material that is also a severe skin and eye irritant. Symptoms often seen include: dizziness, nausea, decreased attentiveness, paresthesia, somnolence, altered sleep time, convulsions, euphoria, change in cardiac rate, and a severe eye and skin irritant. The US DHHS, the WHO, and the EPA have determined that methylene chloride is a probable carcinogen. This chemical is a known carcinogen. The ACGIH TLV is set at 50 ppm.

Napthalene
Napthalene is a naturally occurring material typically used to make the insecticide carbaryl. Symptoms often seen include: damage to red blood cells, fatigue, lack of appetite, restlessness, nausea, skin and eye irritant, headache, diaphoresis, hematuria, fever, anemia, liver damage, vomiting, renal shutdown, corneal damage, convulsions, and coma. The US DHHS, the IARC, and the EPA have determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV and NIOSH REL are set at 10 ppm.

Pentachlorophenol
Pentachlorophenol is a synthetic chemical that is extremely dangerous and was used as a pesticide. Symptoms often seen include: acute poisoning marked by weakness, changes in respiration, blood pressure, and urinary output, dermatitis, convulsions and collapse, anorexia, weight loss, sweating, headache, dizziness, nausea, vomiting, breathing difficulty, chest pain, and liver and kidney injury. The EPA and the IARC have determined this chemical to be a probable carcinogen. This chemical is a known carcinogen. The ACGIH TLV and NIOSH REL are set at 0.5 mg/m^3.

Phenol
Phenol is a synthetic chemical that was widely used as a pesticide. Symptoms often seen include: severe eye and skin irritation, kidney, liver, pancreas, and spleen damage, edema of the lungs, anorexia, weight loss, weakness and exhaustion, muscle ache, pain, corrosion of the lips, mouth, throat, esophagus and stomach, gangrene and even death. The carcinogenicity of this chemical is unknown. The ACGIH TLV and NIOSH REL are set at 5 ppm.

Toxaphene
Toxaphene, also known as Chlorinated Camphene, is an insecticide that mimics natural hormones. Ingestion and skin contact result in somnolence, convulsions or effect on seizure threshold coma, and allergic skin dermatitis. Symptoms of exposure may include nausea, confusion, agitation, tremor, convulsions, unconsciousness, or dry and red skin. Carcinogenicity of toxaphene is probable. The MCL is set at 0.003 mg/L and the ACGIH TLV is set at 0.5 mg/m^3.

2,4,5-TP
2,4,5-TP, also known as (2,4,5-Trichlorophenoxyl)Proprionic Acid, is commonly referred to as Silvex. Ingestion results in poisoning.

The carcinogenicity of Silvex is probable. The MCL is set at 0.05 mg/L, but the ACGIH TLV has not been determined.

2,4,5-T

2,4,5-T**,** also known as 2,4,5-trichlorophenoxyacetic acid, is readily absorbed through inhalation and ingestion and slowly through contact. Effects of exposure include: weakness, lethargy, anorexia, diarrhea, ventricular fibrillation. Chronic exposure can result in cardiac arrest and even death. The MCL has not been determined, but the ACGIH TLV and NIOSH REL are set at 10 mg/m^3.

Xylene

Xylene is a naturally occurring material in petroleum and coal tar. This chemical is a severe skin and eye irritant and greatly affects the brain. Symptoms often seen include: olfactory changes, conjunctiva irritation, pulmonary changes, headaches, lack of muscle coordination, dizziness, confusion, difficulty breathing, and gastrointestinal discomfort. This chemical is a dangerous fire hazard when exposed to heat or flame. The IARC has determined the carcinogenicity of this chemical is not classifiable. The ACGIH TLV is set at 100 ppm.

o-Xylene

o-Xylene, also known as 1,2-Dimethylbenzene, is a mildly toxic chemical. This chemical is a very dangerous fire hazard when exposed to heat or flame. Symptoms often seen include: irritation to the eyes, skin, nose, and throat, dizziness, excitement, drowsiness, incoordination, staggering gait, corneal vacuolization, anorexia, nausea, vomiting, abdominal pain, and dermatitis. The ACGIH TLV and NIOSH REL are set at 100 ppm.

Radionuclides

Radionuclides are atoms with structures that are out of balance. The atoms are continually changing, or decaying, into a more stable form. The decay process releases energy, otherwise known as radiation. Any alteration to the delicate balance that atoms maintain affects the structure and stability of the cell. As radiation strikes an atom, the balance is disrupted and the atom gains a positive or negative charge. These atoms are called ions and the ionization of atoms and molecules inside a living cell results in damage to the cell.

Ionizing radiation results in health problems. There are three important types of radiation that cause ionizing radiation: alpha and beta particles, and gamma rays. Alpha particles are large enough particles that the outer layer of dead skin will prevent the penetration of alpha particles into the human body. However, if an alpha particle does indeed enter into the lungs, the ionizing energy will break through cell walls. These particles have a charge of +2. The positive charge enables these particles to be effective ionizers that travel at relatively slow speeds and short ranges.

Beta particles are smaller negatively charged particles that are the equivalent to electrons. These particles originate in the nucleus whereas electrons originate outside the nucleus. Although beta particles are not radioactive, the atoms that emit the particles are. The energy and speed result in damage to cells. Solid objects stop these particles easily.

Gamma rays have incredibly high energy and can easily pass through lead and several feet of concrete. These particles don't need to be ingested or inhaled to seriously damage the human body.

Damage brought about by exposure to radioactivity results in cancer. All radionuclides are known carcinogens. In regards to other chemicals, the carcinogenicity is not always certain.

Plutonium

Plutonium is a radionuclide that is extremely dangerous. Plutonium-236 is an alpha emitter. The high radiotoxicity of plutonium determines the toxicity of plutonium compounds in addition to other atoms in the compounds they form. Any event that further spreads this radionuclide into the environment is dangerous to the life and land. This chemical was created expansively in nuclear weapons production and nuclear power plants. The MCL is set at 15 pCi/L.

Strontium

Strontium is a radionuclide with similar properties to calcium. Strontium-90 is a beta emitter. The stable form has low toxicity and ignites spontaneously in air. When strontium is combined with water or steam, it reacts vigorously to evolve into hydrogen. The MCL is set at 50 pCi/L.

Thorium
Thorium is a radionuclide found in nature. Thorium -232 is an alpha emitter. The carcinogenicity of thorium is probable. The MCL is set at 15 pCi/L.

Tritium
Tritium is a radionuclide that is not an external radiation hazard. This radionuclide is an alpha emitter. When tritiated water is ingested, the blood distributes the materials equally among all of the body fluids. As a human is exposed to tritium, the soft tissues are irradiated. The MCL is set at 20,000 pCi/L.

Uranium
Uranium is a radionuclide found in the environment that is highly toxic on an acute basis. Uranium-238 is an alpha emitter. Exposure at high-levels to uranium results in kidney damage, acute arterial lesions, and cancer. Soluble uranium compounds can be absorbed rapidly into the body. The MCL is set at 20 µg/L and the ACGIH TLV is set at 0.2 mg/m^3.

ENDNOTES

[1] Rachel's Environmental Health News, #640 – Chlorine Chemistry News, March 04, 1999.

[2] Rachel's Environmental Health News, #498 – Dangers of Chemical Combinations, June 13, 1996.

[3] http://www.envirohealthaction.org/toxics/heavy_metals/

APPENDIX 1. Abbreviations and Acronyms

ACGIH – American Conference of Governmental Industrial Hygienists

ATSDR – Agency for Toxic Substances and Disease Registry

DHHS – Department of Health and Human Services

DOE – U.S. Department of Energy

EPA – Environmental Agency

FDA – Food and Drug Administration

HR – Hazard Rating

IARC – International Agency for Research on Cancer

MCL – Maximum Contaminants Levels (mg/L)

NIOSH – National Institute for Occupational Safety and Health

OSHA – Occupational Safety and Health Administration

The OSHA sets permissible exposure limits (PELs) to protect workers against adverse health effects resulting from exposure to hazardous substances.

PAH – Polycyclic Aromatic Hydrocarbon

PCB – Polychlorinated biphenyl

pCi – pico-Curies, measurement of radioactivity

PELs – Permissible Exposure Limits

The PELs determined hazardous substances are enforceable, regulatory limits on allowable indoor air concentrations.

PETN – Pentaerythritol tetranitrate

REL – Recommended Exposure Level

SMCL – Secondary Maximum Contaminants Levels (mg/L)

TLV – Threshold Limit Value

WHO – World Health Organization

APPENDIX 2. Glossary

- **Anemia:** A decreased ability of the blood to transport oxygen
- **Carcinogen:** Any substance that produces or promotes cancer
- **Carcinogenicity:** Ability to cause cancer
- **Irritant:** Abnormal reaction to a substance
- **Long-term:** 365 days or longer
- **Milligram (mg):** One thousandth of a gram
- **Tumor:** An abnormal mass of tissue

APPENDIX 3. Bibliography

BWXT-Pantex, LLC. "2000 Site Environmental Report for Pantex Plant", DE-AC04-00AL66620, May 2001: Tables 6.1-6.2.

Lewis, Richard J. "Hazardous Chemicals Desk Reference," 1993.

Office of the Federal Registry National Archives and Records Administration. *Code of Federal Regulations: Protection of Environment.* Volume 40, Parts 100 to 149. Revised as of July 1, 1994: p. 722-742.

Office of Water, US EPA. "Drinking Water Standards and Health Advisories", EPA 822-B-00-001, Summer 2000.

S.M. Stoller Corporation. "Final FY 2000 Summary and Progress Report for Groundwater Investigations at DOE Pantex Plant", Volume 1. January 29, 2001.

Websites:

ATSDR. "ToxFAQs: Frequently Asked Questions about Contaminants Found at Hazardous Waste Sites", <http://www.atsdr.cdc.gov/toxfaq.html>.

ESER Program. "Gross Alpha Radiation", "Gross Beta Radiation". <http://www.stoller-eser.com/FactSheet/>.

National Institute for Occupational Safety and Health. "NIOSH Pocket Guide to Chemical Hazards", <http://www.cdc.gov/niosh/npg/npg.html>.

US EPA. "Chemicals in the Environment: OPPT Chemical Fact Sheets", April 25, 2001, <www.epa.gov/opptintr/facts.htm>.

US EPA. "Current Drinking Water Standards", January 23, 2002, <http://www.epa.gov/safewater/mcl.html>.

US EPA. "IRIS Substance List", <http://www.epa.gov/iris/subst/index.html>.

US EPA. "List of Contaminants and MCLs", <http://www.epa.gov/safewater/mcl.html>, <http://www.epa.gov/safewater/regs/cfr141.pdf>.

WHO. "Guidelines for drinking water quality." <http://www.who.int/water_sanitation_health/GDWQ/>.

Reigart, J. & Roberts, J. "Recognition and Management of Pesticide Poisonings", Fifth Edition, 1999: <http://www.epa.gov/oppfead1/safety/healthcare/handbook/handbook.pdf>.

http://www.gis.usu.edu/~sanduku/papers/gisca/node14.html