# WORKPLACE CHEMICAL HAZARDS TO REPRODUCTIVE HEALTH



## A Resource for Worker Health and Safety Training and Patient Education

State of California
Department of Health Services
Department of Industrial Relations

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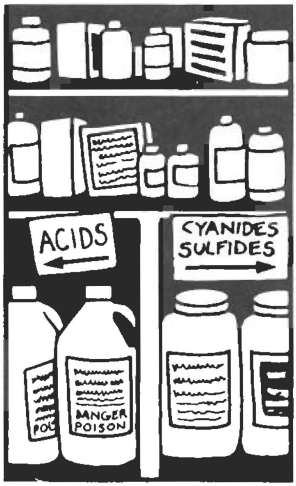
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# WORKPLACE CHEMICAL HAZARDS TO REPRODUCTIVE HEALTH



Many men and women wonder if toxic substances at work, at home, or in their communities affect their ability to have healthy children. They are concerned that chemical exposures might cause reproductive health problems such as infertility, miscarriage, birth defects, mental deficiencies, or cancer in their children. This concern is understandable, since the ability to bear healthy children is often one of the most cherished aspects of life.

Many chemical exposures pose no hazard to reproduction. Some chemicals don't harm the fetus or the reproductive system. In other cases, exposure to chemicals is too brief or too small to create a hazard. However, frequent use of certain chemicals without the proper protections may be cause for concern. It is important, then, that both men and women find out about the chemicals they use at work before starting a family.

This booklet is intended as an aid to patient education and worker health and safety training. It is written for health care providers and people responsible for workplace health and safety. HESIS has also published a less technical fact sheet which deals with evaluating hazards to pregnancy.

To help the reader better understand how hazardous chemicals can affect reproductive health, and how harm can be prevented, this booklet will:

- review the reproductive biology of both men (formation of sperm) and women (menstrual cycle and pregnancy)
- discuss possible reproductive disorders and adverse pregnancy outcomes and how they may be associated with exposure to certain hazardous substances
- summarize the methods used to determine the reproductive toxicity of chemicals

- list a few of the agents which are known reproductive hazards in humans or animals
- summarize the steps involved in evaluating workplace hazards to reproductive health
- provide information on how workers can be protected by reducing their exposures
- give a brief overview of the rights of pregnant workers.
- define some of the more technical words. Some readers may want to refer to the glossary (page 35) as they read this booklet.

## The Impact Of Workplace Chemicals On Reproductive Function

Reproductive disorders and adverse pregnancy outcomes occur frequently in the general population. In most cases the causes are not known, although poor nutrition, alcohol and other drugs, smoking, lack of prenatal care, age, and heredity can all have profound effects on reproduction.



The extent to which workplace chemical exposures contribute to reproductive impairment is much less clear. But even if we don't know *how much* workplace exposures contribute, we do know that they are a preventable cause of reproductive dysfunction. The adoption of work practices which reduce or prevent exposure to hazardous chemicals does not have to wait until we know the exact magnitude of the risk chemical exposure presents.



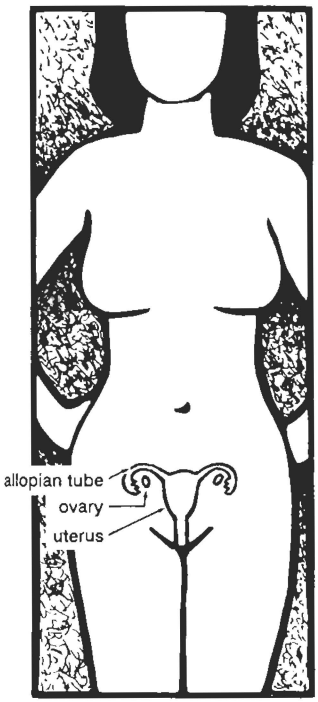
Most industrial chemicals have not been adequately tested for their ability to affect reproduction. For this reason, it is not usually possible to conclude with certainty whether or not a particular chemical exposure can cause harm. However, even when reproductive toxicity information is incomplete, it may be possible to reasonably evaluate risk based on what we do know and estimates of worker exposure. If workplace exposure is controlled to protect workers from all other health effects, it's likely that workers will often be protected from harmful reproductive effects as well.

# REPRODUCTION



A brief review of the reproductive cycles of women and men will help us discuss how workplace exposure to chemicals can affect reproductive function. This section discusses the cycles by which eggs and sperm are formed and the stages of pregnancy.

## A Woman's Reproductive Cycle




Every month during a woman's reproductive years her body prepares itself for childbearing. Monthly changes in the levels of hormones (the body's chemical messengers) in the blood determine when a woman ovulates (releases an egg from the ovary) and menstruates (sheds the lining of the uterus). A woman's entire reproductive cycle is regulated by these hormones. If a chemical disturbed the release of hormones it could cause irregular periods or excessive bleeding. In addition, it could change the timing of ovulation or prevent ovulation from occurring at all. Without ovulation a pregnancy cannot occur. This is how contraceptive (birth control) pills prevent pregnancy. The effect of industrial chemicals on menstrual function has not been studied well. Menstrual disorders have been reported in women exposed to synthetic hormones and inorganic mercury in the workplace.

All of the eggs that a woman will ever have (about half a million) are present in her ovaries at the time she is born, but only about 500 of these eggs will mature and be released during her lifetime. These eggs carry the genes (genetic material) which determine the characteristics she will pass on to her children (eye and hair color, blood type, etc.). Each month several of these eggs mature and one is released into the fallopian tubes. Because a woman's eggs are present throughout her life, they can be damaged by exposure to chemicals at any time. There is some evidence that exposure to high levels of ionizing radiation prior to fertilization can damage the egg and increase the chance of miscarriage. The extent to which preconception exposure to industrial chemicals may

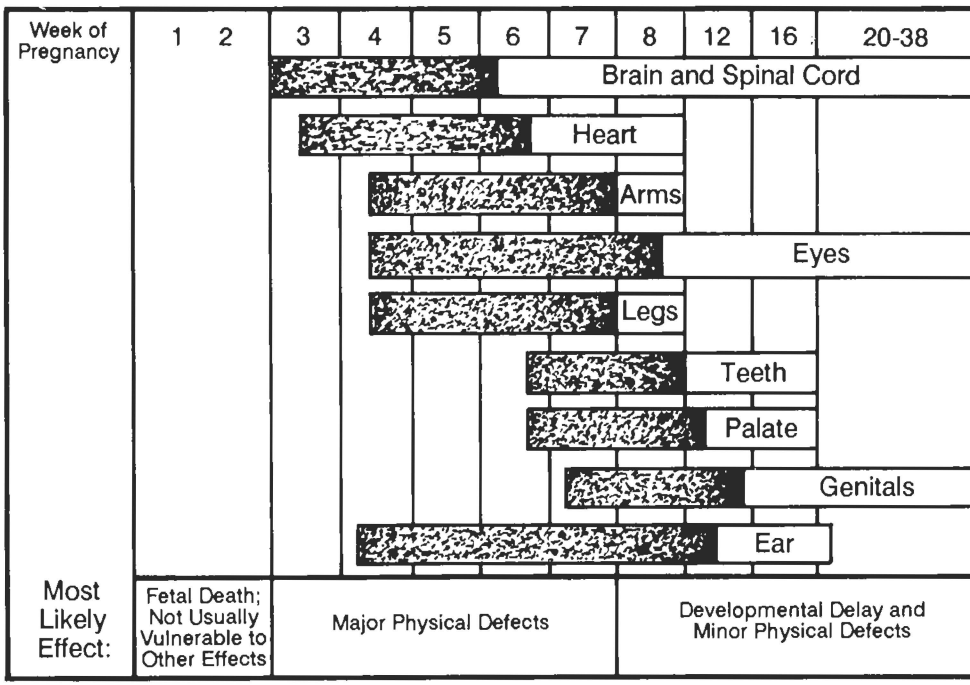
damage the egg is not known. We haven't yet identified other agents which have this effect.

At the same time that eggs are maturing in the ovaries, the lining of the uterus thickens to prepare for a fertilized egg. If fertilization does not occur, the lining of the uterus is shed, resulting in menstruation ("period").

## Pregnancy

If fertilization (the union of egg and sperm to form an embryo) occurs, the fertilized egg travels down the fallopian tube and becomes implanted in the uterus. Some intrauterine device (IUD) contraceptives probably prevent pregnancy by preventing the embryo from implanting. In theory, a chemical could similarly interfere at this stage.

### Sensitive Periods for Effects on Fetus




Shading represents highly sensitive periods; clear area represents periods that are less sensitive to teratogens.

An implanted embryo develops into a fetus, nourished by the mother through the placenta. The nine-month pregnancy is divided into three phases called trimesters. Each trimester is 13 weeks long.

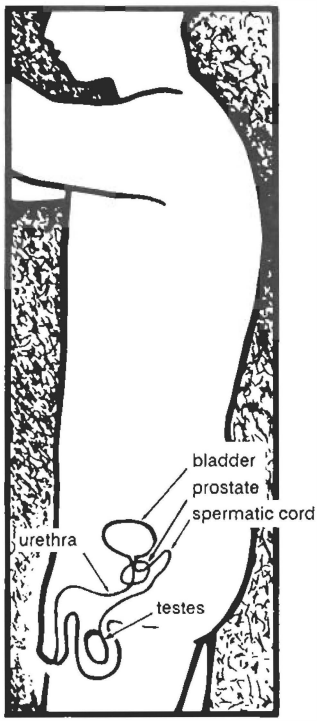
### First Trimester

After implantation and up until the end of the third month of pregnancy, the cells of the fetus rapidly divide and form the organs and limbs. This is the period in which the fetus is most susceptible to agents which can cause physical defects. While some chemicals do not cause physical defects, they can delay normal growth of the fetus. Susceptibility to developmental delay continues throughout pregnancy.

### Second and Third Trimesters

During the second and third trimesters of pregnancy, the fetus grows in size and the organ systems (e.g., the nervous system) develop. From the fourth month until birth, chemicals which can harm the fetus are more likely to affect brain development or result in low birth weight than to cause physical defects. However, certain organ systems (such as the urinary and reproductive systems) develop throughout the pregnancy and remain susceptible to agents which cause physical defects.

## A Man's Reproductive Cycle




Men begin to develop sperm at puberty and continue to produce sperm throughout their adult life. Sperm are produced from special cells (called stem cells) in a man's testicles in a series of steps which takes ten weeks to complete. This cycle of sperm production (spermatogenesis) is, like a woman's menstrual cycle, regulated by hormones. If an agent altered the secretion of these hormones it could disrupt the cycle as well as have an effect on a man's desire for and ability to perform sexual intercourse.

Some chemical or physical agents can damage a man's testicles, the stem cells, or the mature sperm formed from them. This damage can result in a reduction in the number of sperm produced, a total absence of sperm, changes in their shape or ability to move, or changes in the genetic material in the sperm cell. A reduction in sperm count can result in infertility. We don't really know what effect the other changes may have. Changes in shape and mobility might make sperm less likely to fertilize an egg. Changes in genetic material might increase the chance of miscarriage in a man's partner.

Unlike a woman's eggs, which are all present at the time she is born, sperm are produced continually during a man's reproductive years. Once a man is removed from exposure to a damaging agent, recovery of normal sperm production can occur after several months. If the stem cells have been damaged, however, sperm production can be permanently affected.

# REPRODUCTIVE DISORDERS AND ADVERSE PREGNANCY OUTCOMES



Birth defects are the most highly publicized of all adverse reproductive outcomes, yet chemicals can affect reproductive function in men and women at any stage and can cause a variety of adverse outcomes. The specific effect produced depends on the agent, the dose, and the timing of exposure. The range of potential adverse reproductive outcomes and the possible mechanisms by which reproductive toxins may exert their effects are discussed below.

## Reduced Sex Drive

Chemicals which affect the nervous system or the secretion (release) of sex hormones could lower the sex drive or alter sexual response in both men and women. Changes in sex drive or sexual response are usually accompanied by other symptoms of toxicity. Other factors which can affect sex drive include fatigue, stress, illness, and some medications.

⇒ **Examples:** lead (a metal used in battery manufacture, soldering and many other occupations);
mercury (a metal used in medical devices, in making dental amalgams, etc.)

## Infertility

Infertility is the inability of a couple who want a child to become pregnant after trying for one year. About 10 to 15% of couples fail to conceive after one year of unprotected intercourse. Factors which have been associated with infertility include a history of sexually transmitted disease, substantial weight loss, and advanced maternal age. Chemicals could cause infertility by:

In men:

- damaging the testes, resulting in inability or reduced ability to produce sperm.
- directly damaging the sperm, leading to reduced sperm count or abnormally shaped sperm. Abnormally shaped sperm might be less likely to fertilize an egg.

⇒**Examples**: 2-methoxyethanol (an industrial solvent); dibromochloropropane (a pesticide, banned for use in the United States)

In women:

- directly damaging the egg.
- changing the balance of sex hormones, which could result in a lack of ovulation (release of egg) or abnormal periods. Menstrual irregularities are a common problem and are often due to stress, changes in diet or exercise, or other factors. There is only limited evidence in humans that chemical exposure contributes to menstrual irregularities. However, changes in menstrual function are difficult to measure and have not been studied well.

⇒**Examples**: lead; ionizing radiation

## Spontaneous Abortion

Spontaneous abortion is a naturally occurring loss of the embryo or fetus before full term. It is estimated that 15% to 30% of all pregnancies end in spontaneous abortion. A spontaneous abortion can occur before a woman knows she is pregnant, so that all she is aware of is a late, possibly heavy, period. The causes of these spontaneous abortions are largely unknown. Several factors known or suspected to be associated with an increased risk of spontaneous abortion are advanced maternal age, smoking, gynecological disorders such as physical abnormalities of the uterus, and infection. Chemicals could cause a spontaneous abortion by:

In men:

- damaging the genetic material in the sperm so severely that an egg fertilized with this sperm cannot survive. This has been seen in animals but not yet in humans.

⇒**Example**: ethylene oxide (a chemical sterilizing agent)

In women:

- damaging the genetic material in the egg so severely that the egg cannot survive once fertilized.
- preventing the fertilized egg from implanting in the uterus.
- directly affecting the developing embryo or fetus, causing a lethal (deadly) physical defect or lethal toxic effect.

⇒**Examples**: lead; anesthetic gases; antineoplastic drugs (drugs used to treat cancer)

## Birth Defects

A birth defect is a physical abnormality present at birth, although it may not be detected until later. About 2% to 3% of all newborns have a serious defect. The proportion of these birth defects which is attributable to hazardous substances is unknown. In fact, the causes of most defects are not known. Several factors which are associated with an increased risk of birth defects are poor nutrition, advanced maternal age, certain maternal diseases such as diabetes and sickle cell anemia, and certain maternal infections such as rubella (German measles) and toxoplasmosis.

Chemicals can cause birth defects by directly damaging tissues in the developing fetus. Agents which cause birth defects are called *teratogens*. The period of most concern is the first trimester, because this is when the organs and limbs are being formed. During this period many women are not yet aware that they are pregnant and therefore may not take appropriate measures to protect themselves from exposure to agents which can cause birth defects.

Some chemicals can harm the fetus even at exposure levels that do not affect the mother, so that the mother may have no symptoms to warn her that her fetus is being harmed.

⇒**Examples**: glycol ethers; ionizing radiation (X-rays, radiologic medicine); antineoplastic drugs

## Fetotoxicity

Some agents can delay the growth or harm the health of the fetus without causing physical defects. These agents are called *fetotoxins*. The most common fetotoxic effect is low birth weight. Babies with particularly low birth weight are at increased risk of illness or death in the first year of life. Fetotoxicity can occur at levels of exposure not toxic to the mother. Factors which have a significant effect on fetal growth and birthweight are nutrition, smoking, and consistent prenatal care.

⇒**Examples**: ethanol (alcohol); smoking; toluene (an industrial solvent)

## Neurobehavioral Defects

The mental development and behavior of infants and children can be harmed by substances that their mother was exposed to during pregnancy. The effects include hyperactivity, irritability, decreased attention span, slow learning ability, and in severe cases, mental retardation. They can occur in addition to physical defects or alone, and may not be apparent at the time of birth. Some of these effects may be temporary (e.g., irritability), while others are permanent (e.g., mental retardation). Exposure to toxic substances before birth is only one of many factors which can affect the development and behavior of a child. Other factors which have a profound effect on a child's development are nutrition, genetic defects (for example, Down's Syndrome), interactions between the child and his or her parents, and the quality of the child's education. Only a few drugs and even fewer industrial chemicals have been identified which cause neurobehavioral defects. However, neurobehavioral defects are difficult to measure and have not been well studied.

⇒**Examples**: lead; ethanol; narcotic drugs (e.g., cocaine, heroin)

## Childhood Cancer

Many cancer-causing substances (carcinogens) can reach the fetus through the mother. Some can cause cancer in the child or young adult. These chemicals are called *transplacental carcinogens*. There are very few known transplacental carcinogens. However, any carcinogen which can cross the placenta should be considered a potential transplacental carcinogen.

⇒**Example**: diethylstilbestrol ("DES," a drug given to many pregnant women in the 1950's-60's. A small percentage of their daughters develop a rare type of cancer as young adults.)

## Exposure After Birth

Many toxic chemicals concentrate in fat tissue once they are absorbed into the body. Since breast milk is high in fats, a breast-feeding child can be exposed to these toxic chemicals (e.g., perchloroethylene). Other chemicals leave the body within a very short period of time or do not concentrate in breast milk and should not pose a problem to the breast-feeding infant.

If chemicals, especially metal dusts such as lead and cadmium, are brought home on skin or clothes, children may also be exposed. Good personal hygiene (showering or washing after work, changing out of work clothes and shoes) can prevent this type of exposure.

# HOW DO WE KNOW WHETHER A CHEMICAL CAN HARM REPRODUCTIVE FUNCTION?



There are three types of studies which scientists use to determine whether a chemical can harm reproduction: studies of human populations (epidemiological studies), studies of animals, and tests for mutagenicity (the ability to damage genetic material). Each of these methods has strengths and weaknesses in helping us to understand reproductive hazards and to take action to prevent them.

## Human Studies

Epidemiologists study human populations to look for unusual or abnormal patterns of health problems. They try to determine whether these unusual patterns are associated with a particular exposure. These studies provide the most reliable evidence for human reproductive hazards. However, it is difficult to show that harm to pregnancy or reproduction in humans is the result of exposure to a specific substance. Humans are difficult to study because we are usually exposed to many substances at the same time and it is often difficult to estimate the level of exposure to a particular substance. Also, harm to pregnancy or reproduction is often difficult to measure. Finally, epidemiologists must study very large numbers of people to be able to detect a difference between exposed and unexposed people. Because of these difficulties, few agents have been studied in humans.

One disadvantage to relying on epidemiological evidence is that we can't recognize problems until they actually occur in humans. In contrast to studies in humans, animal studies and tests of mutagenicity can serve as warnings of a potential hazard before people are harmed.

## Animal Studies

Standard animal reproductive toxicity tests expose groups of laboratory animals to different amounts of a chemical for different periods of time. These animals are then compared with animals that were not exposed, to see if there are differences in sperm production, birth defects in offspring, or other reproductive functions.

We usually assume that most agents which harm reproduction in animals also have the potential to harm human reproduction. Although there may be exceptions, we make this assumption because most known human reproductive toxins have similar effects in laboratory animals. Most of our information about reproductive hazards comes from testing animals.

## Tests of Mutagenicity

One way to predict whether a chemical could affect reproduction is to determine in laboratory tests whether it causes mutations (changes in the genetic material of a cell). The use of mutation studies to predict reproductive toxicity is based on the assumption that if mutations occur in laboratory test cells, they could also occur in human germ cells (egg or sperm). However, not all mutagens (chemicals which cause mutations) adversely affect reproduction, and not all reproductive toxins are mutagens.

Scientists sometimes use these tests for screening chemicals to determine which ones should have the highest priority for animal testing.

# SPECIFIC CHEMICALS



Most of the thousands of industrial chemicals in use today have not been tested for their ability to affect reproductive function. Compared to our knowledge of the immediate health effects of chemicals, little is known about the ability of chemicals to affect reproduction. For this reason, it is not usually possible to conclude with certainty whether or not a particular exposure can cause harm. *The surest way to prevent toxic chemicals from causing harm to workers or to a developing fetus is to minimize or prevent exposure.*

Since it is not possible to discuss all the agents that workers may be exposed to, we have provided information in the following tables (Tables 1 to 4) on a few of the chemical compounds most frequently encountered in California workplaces. Chemical agents are classified as *known* reproductive toxins, *probable* reproductive toxins, *possible* reproductive toxins, and substances *unlikely* to harm reproduction.

This is *not* a list of reproductive toxins which may be encountered in the workplace. It *is* a list of chemicals men and women frequently inquire about, accompanied by a *qualitative* assessment of potential for reproductive harm. **Just because a chemical is not on this list does not mean that it is safe.**

Because this booklet focuses on reproductive health effects, the general health effects of the substances on the following lists are not identified or discussed. Readers are encouraged to obtain general toxicity information from another source (see page 32).

# Table 1

**A Few Known Human Reproductive Toxins Which May Be Encountered in the Workplace**

| Substance | Effect | Comment |
|---|---|---|
| lead | • reduced sperm count<br>• spontaneous abortion<br>• low birth weight<br>• behavioral abnormalities | some effects may occur at levels below those which cause other toxic effects |
| antineoplastic drugs | • birth defects<br>• spontaneous abortion<br>• reduced sperm count | effects may occur at levels below those which cause other toxic effects |
| diethylstilbestrol (DES) | • cancer in children | no longer widely used; possible exposure in the pharmaceutical industry |
| dibromochloropropane (DBCP) | • damages testes | use is banned in the United States |
| ethanol (alcohol) | • birth defects<br>• low birth weight<br>• behavioral abnormalities | unlikely to occur through occupational inhalation exposures; significant risk through ingestion |
| ionizing radiation | • birth defects<br>• spontaneous abortion<br>• low birth weight<br>• cancer in children<br>• reduced sperm count | recommended dose limit to the fetus in occupationally exposed women is 0.5 rem during the entire pregnancy |

Note: "Effect" refers to adverse reproductive effect that has been associated with this substance in human or animal studies. *This does not mean that this effect will necessarily occur in response to exposure.* Response depends on a number of factors, including dose, and the point in the reproductive process at which exposure occurs.

# Table 2



**A Few Probable Human Reproductive Toxins Which May Be Encountered in the Workplace**

| Substance | Effect* |
|---|---|
| 2-methoxyethanol** | • birth defects (A)<br>• reduced sperm count (A) |
| 2-ethoxyethanol** | • birth defects (A)<br>• reduced sperm count (A/H) |
| ethylene oxide** | • toxic to sperm (A)<br>• spontaneous abortion (A/H) |
| nitrous oxide** | • spontaneous abortion (A/H)<br>• birth defects (A) |
| cycloheximide** | • birth defects (A)<br>• damages testes (A)<br>• toxic to sperm (A) |
| mercury (inorganic)** | • birth defects (A)<br>• fetotoxicity (A)<br>• menstrual irregularities (H) |

* See "Note" at the bottom of Table 1.

** Reproductive effects may occur at lower exposure levels than other toxic effects, so that there may be no obvious symptoms to warn that workers' reproductive health is being harmed.

A = evidence in animals;
H = limited evidence in humans

# Table 3



**A Few Possible Human Reproductive Toxins Which Are Frequently Encountered in the Workplace**

| Substance | Effect* |
|---|---|
| methyl ethyl ketone | • fetotoxicity** (A) |
| methanol | • birth defects at very high exposure levels** (A) |
| methylene chloride | • fetotoxicity** (A) |
| trichloroethane (TCA) | • fetotoxicity** (A) |
| perchloroethylene | • fetotoxicity** (A) |
| styrene | • death of the embryo** (A) |
| xylene | • fetotoxicity** (A)<br>• birth defects at levels toxic to mother** (A) |
| toluene | • fetotoxicity** (A)<br>• birth defects*** (H) |

* See "Note" at the bottom of Table 1.

** In animals, this does not occur at exposure levels near the Permissible Exposure Limit (PEL). However, because of the uncertainty inherent in animal testing, workplace exposure should be minimized.

*** Case reports in children of women who abused toluene (by sniffing glue) throughout pregnancy.

A = evidence in animals;
H = limited evidence in humans

# Table 4



**A Few Substances Which Are Unlikely to Harm Reproduction**

Some chemicals are not likely to harm reproductive function, because very little of the chemical is absorbed into the bloodstream. For example, strong irritants react with the first body tissue they contact, usually the eyes, nose, throat, or skin. Therefore, they are unlikely to affect other parts of the body, including the fetus. However, most of these substances can have other serious effects at the site of contact. A few chemicals which are believed to pose no danger to pregnancy or reproduction are listed below.

ammonia
chlorine
hydrochloric acid
nitric acid
sulfuric acid
sodium hydroxide
potassium hydroxide
sodium hypochlorite (bleach)
fiberglass
asbestos
silica

# FACTORS THAT DETERMINE HAZARD TO REPRODUCTION



In order for a chemical to harm the developing fetus or the reproductive systems of men or women, it must first enter the body and circulate in the bloodstream. Several factors determine whether a chemical can harm a worker or a developing fetus:

- the route of exposure (how the chemical enters the body)
- the dose (the amount of the chemical absorbed into the body and how much reaches the fetus); and
- the toxicity of the chemical itself.

## Route of Exposure

In the workplace, the most common routes of exposure to chemicals are by inhalation (breathing a substance into the lungs), skin absorption, and accidental ingestion (swallowing).



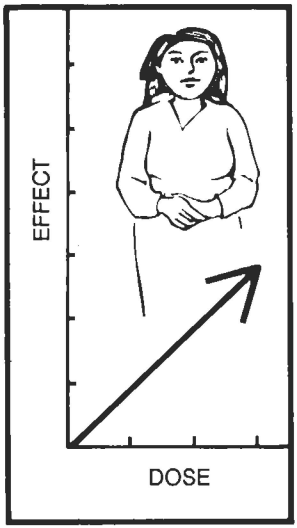
**Inhalation:** Inhalation is the most common way that workplace chemicals can enter the body. Some chemicals, such as ammonia, are potent irritants. Since these chemicals react with the first tissue they contact, very little enters the bloodstream; therefore they are unlikely to affect other parts of the body, including the reproductive system or a developing fetus. Other chemicals, however, are absorbed through the lungs into the bloodstream, can reach the reproductive organs or the developing fetus, and may cause harm.

**Skin contact:** The skin is a protective barrier that helps keep foreign chemicals out of the body. However, some chemicals can be absorbed though the skin and enter the bloodstream. If the skin is cut or cracked or if a skin rash is present, chemicals can penetrate the skin more easily.

**Ingestion:** Swallowing chemicals is the least common source of exposure in the workplace. Chemicals can be ingested if they are left on hands, clothing, or beard, or if they accidentally contaminate food, drinks, or cigarettes.

Chemicals present in the workplace as dusts (for example, metal dusts such as lead or cadmium) are easily ingested.

## Dose




In general, the greater the amount of a substance that enters the body, the greater is the likelihood or the severity of an effect on the individual and/or a fetus. This connection between amount and effect is called the dose-response relationship. When an individual is exposed to a toxic chemical, the dose received depends on several factors:

- the level (concentration) of chemical in the air;
- how hard (fast and deep) he or she is breathing, which depends on the degree of physical exertion;
- the degree of skin contact (for chemicals which can be absorbed through the skin);
- the potential for ingestion through hand-to-mouth contamination;
- how easily the chemical is absorbed into the bloodstream; and
- how long the exposure lasts (duration).

If a worker is pregnant, the dose she receives determines the dose that is received by the developing fetus.

## Toxicity

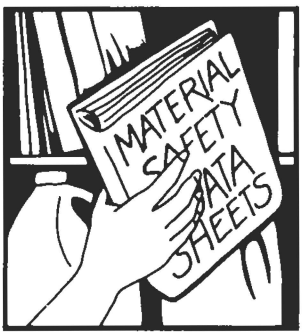
In addition to route of exposure and dose, the toxic properties of the specific chemical determine the effects on the reproductive system or on the fetus. Just as many chemicals do not cause cancer, many chemicals do not harm reproductive function. Since some chemicals are much more toxic to the reproductive system than others, it is necessary to keep exposure to some substances lower than others. Exposure to a specific chemical may be harmful at one level but not at a lower level. Unfortunately, there is not enough information on the reproductive toxicity of many chemicals to determine a "safe" level of exposure. It is wise therefore to keep exposure to any toxic substance as low as is reasonably possible.

# EVALUATING WORKPLACE HAZARDS TO REPRODUCTION



Each worker and worksite is unique; therefore, occupational risks to reproduction must be assessed on a case-by-case basis. A complete evaluation of hazard to reproduction has three steps:

## Hazard Identification




*a) Identify the substance(s) used on the job.*
Information about a product's chemical composition, physical characteristics, and toxicity can be obtained from the Material Safety Data Sheet (MSDS). Under California law, manufacturers must supply an MSDS for any product that contains certain toxic substances. Employers obtain the MSDS when they purchase the product, and must make the MSDS available to employees on request. Employers also have a legal obligation to provide a treating physician with this information if it is requested.

*b) Determine whether there is evidence in animals or humans that the substance is a reproductive toxin.*
Unfortunately, MSDSs rarely include adequate information on reproductive health effects. In most cases, consultation with an occupational medicine specialist or reference to reproductive hazard reference texts or databases is necessary (see "For More Information" on page 32).

## Exposure Assessment

*a) Estimate the level of worker exposure to any hazards identified in step one (i.e., how much, for how long, and how often are workers exposed?).*
Industrial hygiene measurements of air levels of chemicals usually provide the best estimate of worker exposure. For chemicals which can easily be absorbed through the skin, information on the amount of skin exposure is essential. If monitoring has been done, workers have a legal right to see the results relevant to their work area. Usually this information will not be available. The appendix, "Estimating Workplace Exposure," lists the questions that need to be answered in order to roughly estimate levels of exposure when monitoring results are not available.

*b) Estimate the likelihood of a chance high exposure.* Find out if there is a history of unusual situations, such as equipment breakdowns or spills, that may expose workers to other chemicals or to larger amounts of chemicals used routinely.

## Risk Assessment

*Estimate the likelihood of harm based on information gathered in steps one and two (i.e., how close is estimated worker exposure to the lowest dose which causes reproductive harm in animals or humans?).*
Sometimes, assessing risk is relatively simple. For example, occasional worker exposure to small amounts of substances such as paint fumes or roofing tar fumes is unlikely to affect pregnancy or reproduction. In many cases of on-going, frequent exposure to chemicals, however, assessing risk to reproduction is a difficult task. In more complicated situations it may be necessary to consult with an occupational medicine physician, an occupational health clinic, or an industrial hygiene consulting firm.

## Employer's Responsibility

Employers are responsible for evaluating workplace hazards to reproduction, informing employees about these hazards, and protecting them from these hazards to the extent feasible. These responsibilities cannot be passed on to an employee's personal physician. If an employer does not have the professional staff necessary to evaluate occupational risks to reproduction, the employer should engage the services of an industrial hygiene consulting firm, an occupational health clinic, a consulting occupational medicine physician, or the Cal/OSHA Consultation Service (see "For More Information" on page 32).

## Personal Physician's Responsibility

It is the responsibility of the personal physician to determine whether a worker has any special medical conditions that make him or her unusually susceptible to any workplace hazards, so that he or she may need to be treated differently from other employees. For example, women with certain complications of pregnancy, such as high blood pressure or excessive weight gain, may be at higher risk of an adverse pregnancy outcome than women with uncomplicated pregnancies. These complications may make it inadvisable for a woman to continue work-

ing at a job which is physically demanding or requires the use of a respirator.

While it is not the responsibility of the personal physician to evaluate workplace hazards for the employer, he or she does have a responsibility to the patient. If an employer has not conducted an adequate evaluation, a personal physician may be able to help a patient by consulting with an occupational medicine physician, or by referring a patient directly for an evaluation. In some cases, the physician may feel comfortable handling the question on his/her own.

# HOW CAN EXPOSURES BE REDUCED?

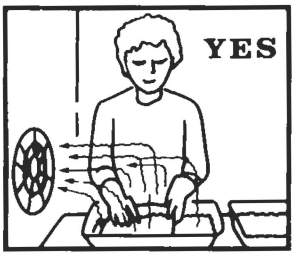


If the evaluation process identifies a hazard to reproduction, action should be taken to reduce the hazard. The most desirable action is to control exposures to acceptable levels for *all* workers.

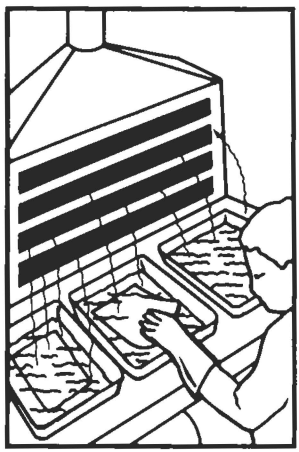
**The surest way to prevent toxic chemicals from causing harm to workers or a developing fetus is to minimize or prevent exposure.** Below are some methods of controlling exposure.

## Engineering Controls

Limiting exposure at the source is the preferred way to protect workers. The types of engineering controls are listed below in order of effectiveness:




**Substitution** is the use of a less hazardous substance. But before a substitute is chosen, its health and safety hazards must be carefully considered. For example, mineral spirits (Stoddard Solvent) and Freon® dry cleaning fluids are less toxic than perchloroethylene; however, mineral spirits pose a greater fire hazard and Freons® are a major cause of environmental air pollution.



**Process or equipment enclosure** is the isolation of the source of exposure, often through automation. This can completely eliminate routine exposure of workers. For example, handling of radioactive materials is often done by mechanical arms or robots.

**Local exhaust ventilation** is a hood or intake, at or over the source of exposure, which draws contaminated air from its source so that it cannot spread into the room and into a worker's breathing zone.

**General or dilution ventilation** is continual replacement and circulation of fresh air sufficient to keep concentrations of toxic substances diluted below hazardous levels. However, concentrations will be highest near the source,

and overexposure may occur in this area. If the dilution air is not well mixed with the room air, pockets of high concentrations may exist.

## Personal Protective Equipment

The following devices should be used only when engineering controls are not possible or are not sufficient to reduce exposure.



**Respiratory protective equipment** consists of devices that cover the mouth and nose to prevent substances in the air from being inhaled. A respirator is effective only when used as part of a comprehensive program established by the employer, which includes measurement of concentrations of all hazardous substances, selection of the proper respirator, training the worker in its proper use, fitting of the respirator to the worker, maintenance, and replacement of parts when necessary.

A worker should not be assigned to tasks requiring use of a respirator unless it has been determined by a physician that he or she is physically able to perform the work while using the required respiratory equipment. If there is a change in health status, it is recommended that a physician be consulted about continued respirator use.

The use of a respirator by a pregnant worker must also be evaluated on a case-by-case basis. Most pregnant women can probably use a respirator without harm. However, certain complications of pregnancy, such as high blood pressure, may make it inadvisable for a woman to continue working at a job which requires the use of a respirator. As with all respirator use, use by a pregnant woman should be evaluated by a qualified occupational medicine physician, taking into account the exposure, the physical demands of the job, the type of respirator, and any complications of pregnancy.



Caution should be exercised in assigning *any* worker to tasks requiring the use of a respirator if a single overexposure, such as could result from respirator failure, could result in significant harm.

**Protective clothing** includes gloves, aprons, goggles, boots, face shields, and any other items worn as protection. It should be made of material designed to resist penetration by the particular chemical being used. Such material is "impervious" to that chemical. The manufacturer of the protective clothing usually can provide some information regarding the substances that are effectively blocked. All protective materials eventually become permeated with chemicals and should be replaced frequently.

## Safe Work Practices

Safe work practices can also reduce exposure to hazardous substances. Employers must instruct workers in general safe work practices and must provide specific instructions about hazards unique to a worker's job assignment (General Industry Safety Orders, Section 3203). Some general recommendations for workers handling hazardous substances are:

- Store chemicals in sealed containers when they are not in use;
- Avoid skin contact with chemicals;
- Do not eat, drink, smoke, or apply make-up in work areas;
- If chemicals spill on you, change out of contaminated clothing right away and wash yourself with soap and water.

# WORKPLACE REGULATIONS




California's Division of Occupational Safety and Health (Cal/OSHA) regulates workplace chemical exposure. Several of the more important regulations are summarized below.

## Hazard Communication Standard

The Hazard Communication Standard (General Industry Safety Order [GISO] 5194) requires employers to provide workers with information about the hazardous substances to which they may be exposed and to train them to use these substances safely. Information on health hazards includes information about hazards to reproductive function. Employers are also required to have an MSDS (see page 21) for any workplace product that contains a hazardous substance, and must make the MSDS available to workers or to a treating physician on request.

## Permissible Exposure Limits

Cal/OSHA establishes Permissible Exposure Limits (PELs) which are intended to protect the health of workers exposed every day over a lifetime of working with a substance (mostly in GISO 5155). These limits are intended to represent the maximum amount (concentration) of a chemical which can be present in the air without presenting a health hazard. However, exposure limits are not always completely protective. The PELs for most chemicals do not take adverse reproductive effects into account. A few exceptions are ethylene glycol methyl ether, ethylene glycol ethyl ether, ethylene oxide, and DBCP.

## Personal Protective Equipment

Employers are required to provide protective clothing and other equipment when necessary (GISO 3380-3400 and 5144). The selection of appropriate protective equipment is a complex task. An industrial hygienist or other knowledgeable person should be consulted to ensure that the equipment is appropriate and is used correctly.

For more information about Cal/OSHA and Cal/OSHA Consultation Services, see page 32.

# PREGNANT WORKERS' LEGAL RIGHTS



There are few well-defined regulatory or legal guidelines to protect workers against reproductive hazards in the workplace. However, there are state and federal laws to protect pregnant workers from discrimination. These laws also provide for limited disability and unemployment benefits and up to four months of unpaid pregnancy disability leave. They do not solve all the problems pregnant workers may face, but they can help. The following is a summary of two of the most important laws.

## Pregnancy Discrimination Act

This law is an amendment to the federal Civil Rights Act. It applies to all workplaces with 15 or more employees. The law establishes that discrimination against women on the basis of pregnancy is sex discrimination, and is illegal. It states that an employer cannot refuse to hire or promote a woman because she is or may become pregnant. It also states that disability due to pregnancy must be treated the same as any other medical disability. An employer may not single out pregnancy-related conditions for special procedures for determining an employee's ability to work.

## Fair Employment and Housing Act

This California law provides the basis for regulations in the California Code of Regulations (CCR), Title 2, sections 7291.1 and 7291.2. These regulations protect pregnant and fertile women from employment discrimination and generally require that an employee temporarily disabled due to pregnancy, childbirth, or related medical conditions must be treated in the same way as any other temporarily disabled employee. The law covers all businesses with five or more employees.

Discrimination: Under the law, discrimination in employment because of pregnancy, childbirth, or related medical conditions is sex discrimination and is illegal. Employers cannot require that an employee be sterilized as a condition of employment.

Disability Leave: In general, the law requires large employers (those with more than 14 employees) to treat disability due to pregnancy the same as any other medical disability. Any benefits or privileges available to other temporarily disabled employees, including transfer to a less hazardous or strenuous position, must be available to employees disabled due to pregnancy. An employer may not single out pregnancy-related conditions for special procedures for determining an employee's ability to work. The law also requires employers to provide unpaid leave for pregnant workers during the period of pregnancy disability (for not more than four months), with the right of reinstatement to the same (or, under certain circumstances, to a substantially similar) job. Women have this right to a pregnancy disability leave even if the employer does not provide such a leave for other temporary disabilities.

Transfer Rights: If working conditions pose a greater danger to the health, safety, or reproductive functions of employees of one sex than to individuals of the other sex, employers must in most cases make reasonable accommodation either to alter working conditions to eliminate the danger or, upon the request of the employee of the endangered sex, to transfer the employee to a less hazardous position for the duration of the greater danger. If an employee disabled by pregnancy, childbirth, or a related medical condition transfers to a less hazardous position, an employer must allow her to return to her original job or to a substantially similar job when she is no longer disabled.

## Employer Policies

Some employers have set up their own policies for pregnant workers, and some offer benefits in addition to those required by law. Workers should ask their employers about the policies in their workplace. Employer policies regarding hazard to pregnancy or reproduction must not violate existing laws prohibiting sex discrimination, and in most cases any benefits available to other temporarily disabled employees must be available to employees disabled due to pregnancy.

*If a worker feels that her employer has discriminated against her because of pregnancy, childbirth, or related medical conditions, she may file a complaint with:*

Department of Fair Employment and Housing (DFEH) — See "State Government Offices" in the government section of the white pages of the phone book.

*If a woman wishes to file for unemployment and/or disability benefits, she should contact:*

Employment Development Department (EDD) — See "State Government Offices" in the government section of the white pages of the phone book.

*For information on unpaid pregnancy disability leave, contact:*

Department of Fair Employment and Housing (see above).

# CONCLUSION



It is important to remember that exposure to chemicals is only one of many factors which can harm reproductive function. In addition, much is still unknown about the extent to which workplace hazards contribute to reproductive problems. However, workplace exposure to chemicals is a *preventable* cause of reproductive harm. Therefore, the goal for employers and workers should be to reduce exposures as much as is reasonably possible. This is the surest way to prevent toxic chemicals from harming workers or the fetus.

# FOR MORE INFORMATION



Employees who want information or help with workplace health and safety regulations, or who want to file a complaint, should contact the nearest office of California's Division of Occupational Safety and Health (Cal/OSHA). See "State Government Offices, Industrial Relations, Occupational Safety and Health" in the government section of the white pages of the phone book.

**Cal/OSHA Consultation**

Employers who want free help to evaluate and improve workplace health and safety should contact the nearest office of the Cal/OSHA Consultation Service. This is a non-enforcement program with services available to both public- and private-sector employers. See "State Government Offices, Industrial Relations, Occupational Safety and Health Consultation" in the government section of the white pages of the phone book.

**Hazard Evaluation System and Information Service (HESIS)**

Department of Health Services/
Department of Industrial Relations
850 Marina Bay Pkwy, Bldg P, 3rd Fl
Richmond, CA 94804
www.cdph.ca.gov/hesis

HESIS provides information to workers, employers, and health professionals about the health effects of toxic substances in the workplace and how to use them safely.

**California Teratogen Information Service and Clinical Research Program**

UCSD Medical Center
Department of Pediatrics/8446
200 W. Arbor Drive
San Diego CA 92103-8446
(619) 543-2131 or (800) 532-3749
http://orpheus-1.ucsd.edu/otis

The Teratogen Information Service is a statewide counseling program that offers information to pregnant women, physicians and other interested individuals about the effects that drugs, chemicals, viruses, and physical agents may have on the fetus. The TIS emphasizes clinical drug exposures and performs clinical follow-up

studies of drug-exposed pregnant women. They do not provide counseling on topics such as labor law.

**Personal Physician**

If you are pregnant or think you are pregnant, see your doctor. Consistent prenatal care is one of the most important factors in having a healthy child. If you think that exposure to toxic substances has affected your reproductive health or is hazardous to your fetus, talk to your doctor. Tell him or her what you do and what substances you work with, and describe your concern about the effect these substances may have on you or your fetus.

**Other Resources for Workers**

Workers who need information or are concerned that exposure to toxic substances might affect their health may want to contact a company health and safety officer, company industrial hygienist, company doctor, or union representative.

**Other HESIS Publications**

HESIS has produced other booklets and factsheets on workplace chemicals. The HESIS fact sheet "If I'm Pregnant, Can the Chemicals I Work With Harm My Baby?" is a more basic version of this booklet. All HESIS publications are free. Some are available in Spanish or other languages. For a publications list and order form,

call toll free (866) 627-1586, or
visit http://www.cdph.ca.gov/ohb, or
write to:

HESIS
850 Marina Bay Pkwy, Bldg P, 3rd Fl
Richmond, CA 94804

**Written References**

*Reproductive Hazards of the Workplace*, L.M. Frazier and M.L. Hage, John Wiley & Sons, New York, 1998.

A thorough review of current knowledge about reproductive hazards, containing summary toxicity information about an extensive list of chemicals, as well as sections on physical agents, infectious agents, ergonomics, etc., with introductory chapters addressing normal reproductive biology, risk assessment, risk communications, risk reduction, and laws and regulations.

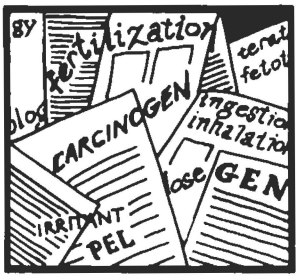
*Occupational and Environmental Reproductive Hazards: A Guide for Clinicians*, Maureen Paul, ed., Williams & Wilkins, Baltimore, 1993.

Very similar to the above, with slightly more orientation toward the health professional audience and less comprehensive attention to specific agents; has chapters on how epidemiology and animal testing work.

*Reproductive Health Hazards in the Workplace*, U.S. Congress, Office of Technology Assessment, Government Printing Office, Washington, DC, OTA-BA-266, 1985.

A report prepared for Congress on the current knowledge of workplace reproductive hazards. This is a broad review that includes sections on reproductive risk assessment, regulation, and ethical issues, in addition to a summary of the principles of reproductive biology and reviews of selected chemicals.

# GLOSSARY




**birth defect** A physical abnormality present at birth. A birth defect may not be detected at the time of birth.

**carcinogen** A chemical or physical agent capable of causing cancer. Such an agent is "carcinogenic." The ability to cause cancer is "carcinogenicity."

**dose** The amount of a chemical that enters or is absorbed by the body. Dose is usually expressed in milligrams of chemical per kilogram of body weight (mg/kg).

**embryo** The developing organism from conception until about 8-9 weeks.

**epidemiology** The study of the pattern of disease in a population of people.

**fertilization** The union of egg and sperm to form an embryo.

**fetotoxin** A chemical agent which delays the growth or harms the health of the fetus without causing physical defects. Such an agent is often described as fetotoxic.

**fetus** The developing organism from about 8-9 weeks until birth.

**gene** The part of the genetic material of a cell that carries a particular inherited characteristic.

**infertility** The inability of a couple desiring a child to become pregnant.

**ingestion** Taking in a substance through the mouth and swallowing it.

**inhalation** Breathing in a substance.

**irritant** A substance which can cause an inflammatory response or a reaction of the eye, skin, or respiratory system.

**menstruation** Shedding the lining of the uterus.

**MSDS** Material Safety Data Sheet. A form which lists the hazardous ingredients, physical and chemical properties, and health and safety hazards of a product or a substance.

**mutagen** A chemical or physical agent which can change the genetic material in cells.

**neurobehavioral defect** Abnormal mental development or behavior in a child that results from damage to, or abnormal development of, the central nervous system (brain) which occurred during pregnancy.

**ovulation** Release of an egg from the ovary.

**PEL** Permissible Exposure Limit, a maximum allowable exposure level under OSHA regulations.

**reproductive health hazards** Agents which can adversely affect sexual function or the ability of men and/or women to produce healthy children.

**respirator** A device worn to prevent inhalation of hazardous substances.

**route of exposure** The way in which a chemical enters the body. The common routes of exposure in the workplace are inhalation, ingestion, and absorption through the skin.

**spermatogenesis** The ten-week cycle of sperm production. Sperm are produced in a man's testicles.

**spontaneous abortion** A naturally occurring death of the embryo or fetus before full term. A miscarriage.

**teratogen** A chemical or physical agent which can lead to malformations (physical defects) in the fetus or in children or animal offspring. Such an agent is "teratogenic." The ability to cause birth defects is "teratogenicity."

**transplacental carcinogen** A carcinogen which crosses the placenta and causes cancer in the child or young adult.

# APPENDIX: Estimating Workplace Exposure



*This questionnaire is for men and women who use chemicals frequently at work.*

**Instructions for Workers:** Read the questions below and collect the information you need to answer them. Share the information you collect with your doctor or other health professional, such as a nurse or genetics counselor. He or she can help you determine if the chemicals you work with can harm you or your fetus. If your health care provider needs help in determining if there is a problem, suggest that he or she consult with a board-certified occupational medicine physician. See page 32 for others who can help.

1. Are you currently employed?

2. What job do you do?
Describe it.

3. What does your company manufacture, or what kind of services does it provide?

4. What are the names of the chemicals in the products you work with?

Brand names aren't very helpful. Sometimes a product label has ingredient information, but often the information on labels is incomplete and unreliable. The best way to find out what chemicals are in the product(s) being used is to get a copy of the *Material Safety Data Sheet (MSDS)* for that product from the employer. An MSDS lists the hazardous ingredients in a product. A sample MSDS and a letter requesting an MSDS are on pages 42 and 43. *Employers are required by law (General Industry Safety Orders [GISO] 5194) to provide workers with a copy of the MSDS, upon request. Employers must also provide this information to a treating doctor on request.*

5. How do you use these chemicals?
Which ones do you use most frequently?
How often?
For how long each time?
How much of each product do you use each time?
Do other people in your area use these chemicals too?
Do people in your area use any other chemicals?
How many people?
What other chemicals?

6. Are any of these chemicals heated?
If yes, which ones?
To what temperature?

7. Can you smell or taste any chemical fumes or vapors where you work?
If yes, which ones?

8. Do you feel sick when you work with any of the chemicals, and feel better at other times?
Describe how you feel.
Did you have these symptoms before becoming pregnant?

9. Do any of the chemicals you work with get on your skin?
If yes, which ones?

10. Do you eat, drink, smoke, or apply make-up in the work area?

11. What kind of ventilation is in your work area?
A hood with power exhaust near the chemical source?
General ventilation (wall fans, roof fans, ceiling vents)?
Natural ventilation (open windows and doors)?
Do you think the ventilation is effective in reducing your exposure?
Is it always turned on when you are using chemicals?
Does it usually work well?

12. Are there any unusual situations at work, such as equipment breakdowns or spills, that may expose you to any other chemicals or to larger amounts of those you use routinely?
Describe them.

13. Do you wear any special clothing, such as gloves or an apron?
If so, what?
What is each item made out of?
Do chemicals leak through the clothing?

14. Do you wear a respirator?
What kind? Paper mask? Hard plastic with cartridges?
What kind of cartridges does it have?
When do you wear a respirator?
What are the specific chemicals for which you wear a respirator?
Have you been fit-tested and trained to use your respirator?

15. Does your employer give you any instructions and warnings about the use of chemicals?
If so, what are they?

16. Have the air levels of chemicals in your work area been measured?
*If monitoring has been done, you have a legal right to see the results relevant to your work area (GISO 3204).*
Do you know the results?
What were they?

17. Do you do any other work outside your regular job, or have any hobbies, which involve exposure to chemicals?
Describe them.

# Sample Letter Requesting Material Safety Data Sheets




Date
Manufacturer
Address

Attention: MSDS Request

Dear Sir/Madam:

The Cal/OSHA Hazard Communication Standard (Section 5194 of the General Industry Safety Orders of Title 8 of the California Administrative Code) requires employers to have in their possession up-to-date Material Safety Data Sheets (MSDSs) for all hazardous substances used in their workplaces. In general, an MSDS should list the hazardous ingredients of a product, describe its health and safety hazards, and suggest ways to use the product safely. It should also contain information about any fire and explosion hazards, first aid, and procedures for cleaning up leaks and spills.

State law requires manufacturers of hazardous substances to prepare and provide MSDSs to their purchasers, either directly or through their suppliers (California Labor Code, Division 5, Chapter 2.5, Section 6390).

Accordingly, we request that you either provide us with current MSDSs for each product which we purchase from your company (see attached list), or provide us with a statement explaining why the product is exempt from these regulations. Also, please certify that your MSDS meets the requirements of GISO Section 5194.

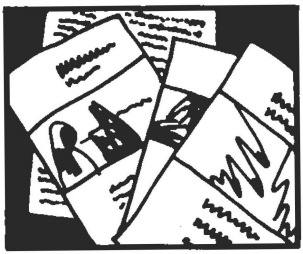
An early reply will be very much appreciated.

Sincerely,

Purchaser's Name
Title
Address

(Note: Copies of the Director's List of Hazardous Substances, the above-mentioned regulations, and general information may be available from Cal/OSHA Consultation Service.)

# HESIS Publications



HESIS publications are available free of charge in limited quantities, and may be reproduced for free distribution. Publications that are available in a language other than English are noted. Where available, please note if you prefer the other language.

**Fact Sheets** are written for workers, employers, and others without formal scientific or medical training. They are 4-6 page summaries of health effects and safe ways to use common chemicals.

Epoxy Resin Systems (6/89)
Ethylene Oxide (2/89)
Fluorocarbons (Freons) (1/89)
Formaldehyde (8/88) (Spanish)
Glutaraldehyde (3/89)
Glycol Ethers (1/89)
Isocyanates (11/89)
Mercury (11/89)
Methyl Bromide (8/88) (Spanish)
Methylene Chloride (1/96)
Methyl Methacrylate (4/89)
PCBs (2/88)
Perchloroethylene (3/89) (Korean)
Styrene (6/89)
Toluene (5/89)
Trichloroethane (5/88)
Trichloroethylene (11/97)
Wood Preservatives (Arsenic and chromate) (9/87)
Xylene (10/89)
"If I'm Pregnant, Can the Chemicals I Work With Harm My Baby?" ('90) (Spanish)
Evaluating Workplace Hazards to Pregnancy: Roles of the Employer and the Personal Physician ('90)
Hepatitis B Vaccination and the Cal/OSHA Bloodborne Pathogens Standard (7/92)
Workplace Exposure to Hepatitis C (12/98)
Tuberculosis (9/96)
Guidelines for Selecting Respirators for Protection Against Tuberculosis ('97)
Occupational Exposure to Rabies
Pulmonary Function Testing (Spanish)

**Hazard Alerts** are summaries similar to HESIS Fact Sheets. They are issued when a new or previously unrecognized hazard is first identified. Later, they are replaced by Fact Sheets.

Chromium-6 (graphical and technical versions) (6/92)
Cycloheximide (7/87)
Ribavirin (12/90)

**BOOKLETS** are much more comprehensive than Fact Sheets. They are generally intended for use by people with some training in health and safety.

Understanding Toxic Substances: An Introduction to Chemical Hazards in the Workplace
HESIS Guide to Solvent Safety ('97; Spanish '85)
HESIS Guide to Metalworking Fluids (accompanied by an illustrated informational flier)
Polish Up Your Jewelry Shop: Guide for Employers
Polish Up Your Jewelry Shop: Guide for Employees
Photography and Your Health: A Guide to Chemical Hazards in the Darkroom
Artificial Fingernail Products: A Guide to Chemical Exposures in the Nail Salon

**TECHNICAL DOCUMENTS** are scientific documentation for Hazard Alerts and selected other chemicals. They are lengthy and highly technical.

Reproductive and Hematopoietic Toxicity of the Glycol Ethers: An Update, With Emphasis on Derivative Compounds ('88)

**MEDICAL GUIDELINES** are brief advisory protocols for diagnosing and managing industrial poisonings when specific antidotal therapy is available. They are written for health care professionals.

Arsenic
Carbon Monoxide
Cyanide
Hydrogen Sulfide
Lead
Mercury
Organophosphates and Carbamates

