Workplace Hazards to Reproduction and Development:

A Resource for Workers, Employers, Health Care Providers, and Health & Safety Personnel

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This booklet was prepared by Sharon L. Drozdowsky, B.S. and Stephen G. Whittaker, Ph.D. Sharon Drozdowsky authored this document while serving as an intern with the Department of Labor & Industries' Safety & Health Assessment & Research for Prevention (SHARP) Program and earning her Master of Environmental Studies degree from The Evergreen State College. Steve Whittaker is a staff toxicologist with SHARP.

This booklet updates and replaces two documents published by SHARP in 1991: "Workplace Hazards to Reproductive Health – A Resource for Health Care Providers, Health and Safety Personnel, and Employers" and "Workplace Hazards to Reproductive Health – A Resource for Workers". The 1991 documents were prepared by Catherine Carr, M.S.; Mary Miller, M.N., A.R.N.P.; Eileen Kirkpatrick M.S.; Nicole Villacres; and James Hawk, J.D. The 1991 booklets were largely adapted from "Workplace Chemical Hazards to Reproductive Health: A Resource for Worker Health and Safety Training and Patient Education" and "Reproductive Hazards Training and Information Manual" produced by the Hazard Evaluation System and Evaluation Service (HESIS), California Department of Health Services, 1515 Clay Street, Suite 1901, Oakland, CA 94612. Portions of the HESIS documents were also adapted for use in this revised (1999) SHARP booklet.

We recommend two publications by the National Institute for Occupational Safety and Health (NIOSH): "The Effects of Workplace Hazards on Female Reproductive Health" (Publication No. 99-104) and "The Effects of Workplace Hazards on Male Reproductive Health" (Publication No. 96-132). These publications complement this booklet, insofar as they provide brief overviews of workplace reproductive and developmental hazards. Some graphics and portions of text were adapted from the NIOSH publications for use in this SHARP booklet.

We wish to thank MICROMEDEX, Inc. for granting permission to reproduce portions of their REPRORISK® database in this document.

We also gratefully acknowledged the review and comments of Labor & Industries staff and our external reviewers.

Contents

Executive Summary

This booklet updates and replaces two documents prepared by The Department of Labor & Industries' Safety & Health Assessment & Research for Prevention Program (SHARP) in 1991: "Workplace Hazards to Reproductive Health – A Resource for Health Care Providers, Health and Safety Personnel, and Employers" and "Workplace Hazards to Reproductive Health – A Resource for Workers."

Our goal was to provide an up-to-date review of reproductive and developmental issues in the workplace. The target audience is broad. We aimed to provide practical information to workers, employers, health & safety personnel, health care providers, and other individuals interested in this topic. The table presented at the end of this Executive Summary provides suggestions as to which sections would interest each reader group.

Readers who would prefer a relatively brief summary of these issues may be interested in two recent publications from NIOSH: "The Effects of Workplace Hazards on Female Reproductive Health" and "The Effects of Workplace Hazards on Male Reproductive Health". You can obtain these booklets from NIOSH by calling *1-800-35-NIOSH* and their web site at *http://www.cdc.gov/niosh*.

The **Introduction** provides an overview of reproductive and developmental issues in the workplace.

Chapter 1, "Reproduction and Development: A Primer," provides basic background information on male and female physiology, in addition to reproductive and developmental toxicology.

Chapter 2, "How Workplace Exposures Can Affect Reproduction and Development," describes the complexity and susceptibility of human reproductive and developmental processes. The spectrum of health problems is described and a few examples of hazardous chemicals, infectious agents, and physical conditions that can affect reproduction and development are provided.

Chapter 3, "Identifying and Evaluating Workplace Risks," provides background information and a step-by- step description of how to perform a risk assessment for reproductive and developmental health problems. Additional guidelines for conducting exposure assessments and designing appropriate intervention strategies are provided in Chapter 4.

Chapter 4, "Guidance for Health Care Providers," is designed to complement the previous chapter, by providing specific guidelines on responding to patient concerns, evaluating worker exposures, and formulating intervention strategies.

Chapter 5, "Guidelines for Workplace Health & Safety Personnel," describes approaches to reducing exposures in the workplace.

Chapter 6, "Responsibilities of Employers," describes how employers can evaluate workplace hazards, inform their employees about workplace risks, and protect them from hazards.

Chapter 7, "Focus on Selected Hazards," provides descriptions of three topical issues in reproductive and developmental toxicology: *Ergonomic Considerations, Video Display Terminals*, and *Endocrine Disruptors*.

Chapter 8, "Workplace Regulations," describes the role of the Washington State Department of Labor & Industries' Washington Industrial Safety and Health Act (WISHA) in ensuring safe and healthful working conditions. Relevant regulations are summarized.

Chapter 9, "Workers' Legal Rights and Responsibilities," provides resources for employees.

"How Workers Can Protect Themselves" is a one-page fact sheet that may be copied and distributed or posted in the workplace.

"Conclusions." Although the risks posed by most workplace agents have not been well-characterized, we suggest that work practices should be adopted that reduce or prevent exposures to any hazard.

"For More Information" provides contact information for several groups that can provide assistance in solving workplace problems. Also included are lists of databases and written references used to prepare this booklet.

The "**Glossary"** provides definitions of technical terms used in this booklet.

"Feedback" provides readers with the opportunity to let us know if this booklet was helpful.

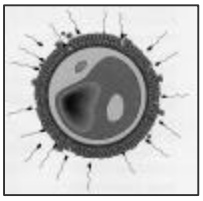
SUGGESTIONS FOR CHAPTERS OF INTEREST TO DIFFERENT READERS

CONTENTS	WORKERS	EMPLOYERS	HEALTH & SAFETY STAFF	HEALTH CARE PROVIDERS
Introduction	●	●	●	●
Chapter 1: Reproduction and Development: A Primer	●	●	●	O
Chapter 2: How Workplace Exposures Can Affect Reproduction and Development	●	●	●	O
Chapter 3: Identifying and Evaluating Workplace Risks	O	●	●	●
Chapter 4: Guidance for Health Care Providers	O	O	O	●
Chapter 5: Guidelines for Workplace Health & Safety Personnel	O	O	●	O
Chapter 6: Responsibilities of Employers	O	●	O	O
Chapter 7: Focus on Selected Hazards	O	●	●	●
Chapter 8: Workplace Regulations	O	●	●	O
Chapter 9: Workers' Legal Rights and Responsibilities	●	●	●	O
How Workers Can Protect Themselves	●	O	O	O
Conclusions	●	●	●	●
For More Information	●	●	●	●
Glossary	●	●	●	O
Feedback	●	●	●	●
Appendix A: Classification of Workplace Hazards	O	O	●	●
Appendix B: Sample Letter Requesting Material Safety Data Sheets	O	O	O	O
Appendix C: Sample MSDS	O	O	O	O
Appendix D: Estimating Workplace Exposure	●	O	●	●

O Suggested, but not essential reading

● Recommended reading

Introduction



Many factors can affect our reproductive health and ability to produce healthy children, including radiation, some chemicals, certain drugs (legal and illegal), cigarettes, some viruses, and alcohol. We may be exposed to these factors at work, at home, or in the community, where they can cause reproductive or developmental problems such as infertility, miscarriage, birth defects, low birth weight, abnormal growth and development, and childhood cancer.

In the past, most public health prevention efforts were focused solely on the mother's exposures, in addition to her diet, and whether she smoked or drank alcohol during pregnancy. Recently however, it has become clear that the process of bearing healthy children relies on a complex series of coordinated events in the father, the mother, and the fetus. Consequently, both men and women are susceptible to reproductive insults, and exposures to either parent, even before conception, may affect the normal development of a child.

Although this information may be alarming to prospective parents, the good news is that many such exposures are readily preventable.

Please note that throughout this booklet, we use the term "reproduction" to describe the processes that occur in both the mother and father before conception. We use the term "development" to describe the events that occur after conception.

This booklet contains information for those of you who are interested in identifying, evaluating, and reducing workplace reproductive and developmental health risks. The information provided ranges from descriptions of basic physiology and toxicology to specific guidance intended for health care providers, workplace health and safety personnel, workers, and employers. This booklet is available from any of L&I's service locations listed in "For More Information", by calling toll free: *1-888-66-SHARP*, or from our web site: *http://www.wa.gov/lni/sharp*.

How Workplace Exposures Can Affect Reproduction and Development

As part of its National Occupational Research Agenda (NORA), the National Institute for Occupational Safety and Health (NIOSH) has developed a list of eight target research areas to improve the health and well-being of United States workers. NIOSH lists "Fertility and Pregnancy Abnormalities" as one of these eight targeted areas and suggests that research and prevention efforts in this area could save industry and society billions of dollars in lost productivity and medical treatment, and alleviate considerable personal suffering.

From the Preamble to NIOSH's NORA Statement on Reproductive Hazards

"While more than 1,000 workplace chemicals have shown reproductive effects in animals, most have not been studied in humans. In addition, most of the 4 million other chemical mixtures in commercial use remain untested. Physical and biological agents in the workplace that may affect fertility and pregnancy outcomes are practically unstudied. The inadequacy of current knowledge coupled with the ever-growing variety of workplace exposures pose a potentially serious public health problem".

It is important to realize that reproductive disorders and adverse pregnancy outcomes are relatively common in the general population. In most cases, the causes are not known. However, poor nutrition, alcohol, smoking, prescription or illicit drugs, lack of prenatal care, age, and heredity all can have profound effects on reproduction and development. The extent to which workplace exposures contribute to such problems is not clear, because there are few studies of such effects in working men and women. Consequently, there is a great deal of uncertainty associated with the reproductive and developmental toxicity of most chemicals, physical conditions, and biological agents.

Although we are uncertain about the extent to which workplace exposures contribute to reproductive and developmental health problems, we know that some workplace chemicals do affect reproduction and development. The use of work practices that reduce or prevent exposure to hazardous agents or job activities does not have to wait until we fully understand the nature and magnitude of the risk.

Chapter 1:

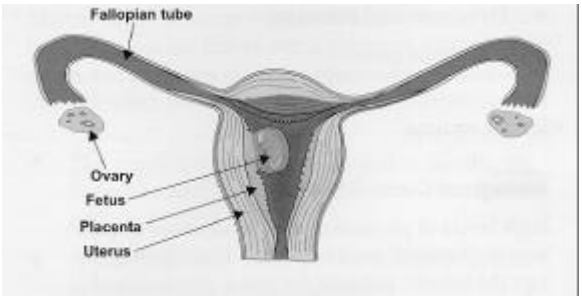
Reproduction and Development: A Primer

A basic knowledge of male and female physiology is important to understand how workplace exposures can affect reproduction and development. This chapter discusses egg formation (oogenesis), sperm formation (spermatogenesis), and pregnancy. Reproductive and developmental toxicology (how toxic exposures may interfere with these systems) will also be discussed. Specific examples of workplace exposures linked with the health effects described here are provided in Chapters 2 and 3.

A Woman's Reproductive Cycle

Physiology

When a woman reaches puberty, her body begins to experience a cyclical process that prepares her for a possible pregnancy. Hormones mediate this monthly process, called the menstrual cycle. In the ovary, several eggs (oocytes) mature until usually one is released from one of the ovaries into a fallopian tube. As the eggs mature, the lining of the uterus thickens in preparation for receiving a fertilized egg. Fertilization occurs in the fallopian tubes. If no egg is fertilized, the woman menstruates (sheds the lining of the uterus). This monthly process



involves coordination among the brain, the pituitary (a small gland at the base of the brain), and the ovary.

A woman is born with all the eggs she will ever have: approximately half a million eggs. About 500 of these will mature, be released, and become available for fertilization throughout her reproductive lifetime. The rest are lost naturally, so that by about age 52, the ovary has no more eggs and the woman enters menopause. Genes in the eggs, along with genes in the father's sperm, help determine many of the characteristics of the child.

Female Reproductive Toxicology

Exposure to hazardous agents can affect the female reproductive system in several ways. Because hormones such as estrogen play such an important part in the process, chemicals that disturb patterns of hormone synthesis, release, or function can cause

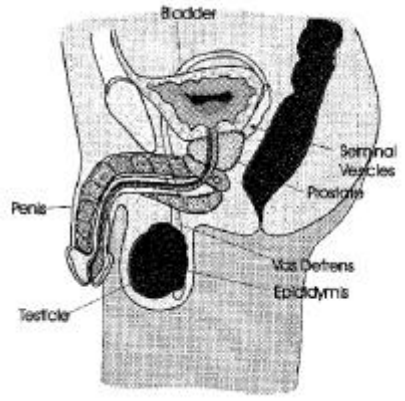
problems in any phase of the menstrual cycle. Some chemicals may actually mimic hormones because they have similar structures. These hormone mimics may affect reproductive function. (The topic of hormone mimics, or endocrine disruptors, is discussed further in Chapter 7.) Other chemicals do not appear to have similar structures, but they have properties that interfere with hormone status, function, and response. Possible consequences of exposure to hazardous substances can be suppression of ovulation (amenorrhea), irregular menstruation, excessive bleeding, or decreased libido. The timing or occurrence of ovulation may also be affected. How chemicals affect menstrual function and libido is a relatively new area and scientific studies are lacking.

A woman's entire complement of eggs is formed before she is born; no new eggs are formed after birth. Consequently her eggs may be lost or damaged at any time. Exposures to agents such as high levels of ionizing radiation have been shown to damage eggs before conception, resulting in infertility and/or an increased risk of miscarriage. Laboratory animal studies suggest that smoking during pregnancy may damage the egg cells of female offspring.

A Man's Reproductive Cycle

Physiology

Men begin active spermatogenesis (sperm production) at puberty and generally produce sperm for most of their lives.



Spermatogenesis is a continuous process and is also regulated by hormones, such as luteinizing hormone (LH), follicle stimulating hormone (FSH), and testosterone. Sperm originate from germ cells, called spermatogonia. Spermatogenesis takes about 72 days; as the sperm mature, they travel through the tubules of the testes and the epididymides. The sperm are then stored in the epididymis for about 15 to 25 days, where they fully mature and develop the ability to swim. Consequently, the sperm that fertilizes a woman's egg actually had a "lifespan" of over two months, during which time it may have been damaged by radiation, chemicals, drugs, and possibly other physical factors, like excessive heat.

Male Reproductive Toxicology

Toxic exposures can alter the production, release, or function of hormones that regulate spermatogenesis. Such exposures can also disrupt spermatogenesis. Decreases in testosterone can also affect a man's desire for, and ability to perform, sexual intercourse.

Some chemical or physical agents can damage a man's testicles, the sperm cells, or the mature sperm. This damage can cause a reduction in the number of sperm produced (resulting in subfertility or infertility), a total absence of sperm, changes in their shape or ability to move (making sperm less likely to fertilize an egg), or changes in the genetic material in the sperm cell (increasing the chance of miscarriage or birth defects in the offspring).

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 may occur after several months. However, sperm production and quality can be permanently affected if the germ cells have been damaged. The ability of cells to replicate can also be lost or compromised.

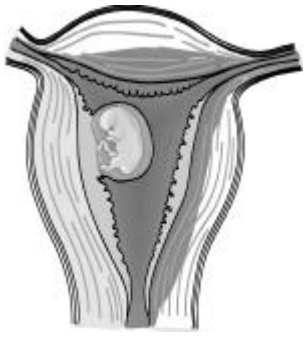
Exposures of men to drugs or workplace chemicals can also affect reproduction and development if the agent is secreted in the seminal fluid. This is known to happen with some chemotherapeutic drugs and lead.

Pregnancy

Pregnancy can only occur if the woman's egg is fertilized. However, many events must take place for the fertilized egg to survive to pregnancy. Recent research suggests that most fertilized eggs do not implant and this very early loss may occur without the woman's knowledge. After fertilization, the egg moves down the fallopian tube and implants in the uterus, where the embryo then develops. The mother nourishes her child during each stage of development through the placenta. The whole period of development takes a little over nine months (39 weeks) and is divided into three equal parts, called trimesters. Specific phases of growth and development occur during each trimester. The figure provided at the end of this chapter illustrates which organs develop during the embryonic period (approximately the first trimester) versus fetal period (approximately the second and third trimesters).

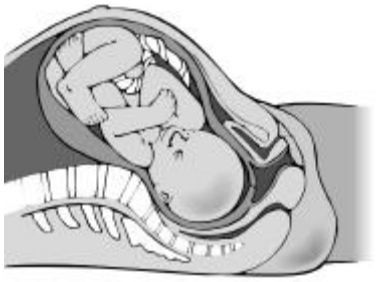
First Trimester:

The first trimester takes place from the time of fertilization until the end of the thirteenth week of pregnancy. During the first trimester, the embryonic cells divide very rapidly, and differentiate into the organs and limbs of the body.



Second and Third Trimesters:

The second and third trimesters are a time of major growth and development. Organ systems such as the circulatory and nervous systems develop and mature. The fetus grows immensely at this time, especially



during the last few months. Most bone growth occurs during this time, and the brain develops its complex organization.

Developmental Toxicology

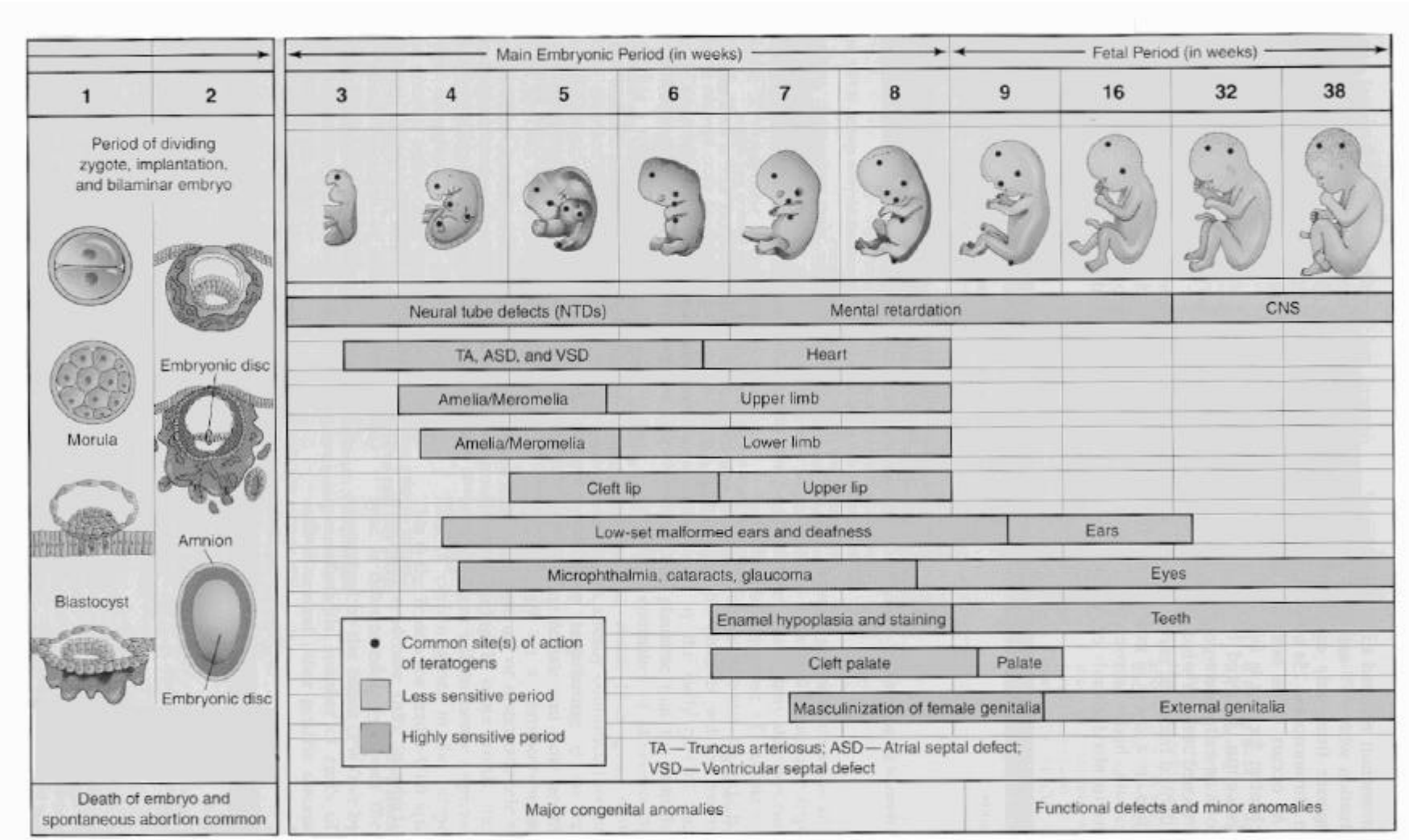
Exposure to certain chemicals, infectious agents, and physical factors can block fertilization, prevent implantation of the embryo, and affect early embryonic development. Implantation is essential for survival of the embryo. Once successful implantation has occurred, chemicals may affect the embryo/fetus by crossing through the placenta and exposing the embryo/fetus directly, or by affecting the maintenance of the fetal/placental unit.

The first trimester is one of the most critical times for the fetus, because extensive development is taking place. Cells are dividing very rapidly at this time to form complex organs. Different exposures may affect the fetus in different ways and the same exposure may have different effects depending on the timing. Exposures such as chemicals or medications may interfere with cell division and formation of the organs. Some exposures may damage the organs or produce a physical defect, while others delay normal growth and development.

Exposures may also interfere with growth and development throughout the second and third trimesters. Later in pregnancy, exposures are less likely to cause physical birth defects, but are more likely to produce low birth weight babies or affect brain development, because brain development continues throughout the third trimester. Achieving an adequate birth weight is very important because low birth weight is a major risk factor for poor health during the first years of life. For example, low birth weight is a risk factor for childhood asthma. A few organ systems (for example, the brain, urinary and reproductive systems) continue to develop throughout the remainder of the pregnancy, and thus, are vulnerable to structural damage in the third trimester.

Factors that Influence Developmental Toxicity

- **Timing of exposure (developmental stage of the fetus)**
- **Amount and route of exposure**
- **Characteristics of the chemical (e.g. toxicity and potential to cross the placenta)**
- **Characteristics of the mother**
- **Characteristics of the placenta**



Adapted from: Moore, Keith L. The developing human: clinically oriented embryology. Eds: Keith L. Moore, T.V.N. Persaud, Philadelphia : Saunders, 1998, 6th ed.

Chapter 2:

How Workplace Exposures Can Affect Reproduction and Development

Background

Even under normal physiological conditions, our reproductive system is not 100% error-free. In a 1998 review article, the Agency for Toxic Substances Disease Registry (ATSDR) estimated that:

- One in 12 US couples are infertile,
- Forty percent or more of conceptions are lost before the 28th week,
- Two to three percent of newborns suffer a major developmental defect,
- Seven percent of newborns are of low birth weight,
- Five percent of newborns are premature (i.e., born before 37 weeks), and
- An undetermined number suffer from developmental or functional problems.

The extent to which workplace exposures contribute to reproductive and developmental health problems is currently unknown. However, it is certain that some workplace chemicals and physical factors can interfere with these complex biological processes. The range of potential adverse outcomes depends on at least three key factors:

- The chemical and/or physical properties of the agent of concern,
- The dose to which an individual is exposed, and
- The timing of the exposure.

The potential risks posed by workplace exposures are difficult to assess because of the complexity of human reproductive and developmental processes, the difficulty in differentiating from other contributing factors, difficulties associated with interpreting laboratory tests, and the lack of available human data.

This chapter will discuss how chemical, biological, or physical exposures can affect the reproductive system and the developing embryo or fetus.

Adverse Outcomes

The overall health of the pregnant woman is the most important predictor of the health of the fetus. Some of the critical factors that

disturb fetal development are poor maternal nutrition, smoking and alcohol, or other drug abuse.

However, it is clear that other exposures can adversely affect reproduction and development, as described in the following subsections.

In the workplace, some exposures may affect the embryo or fetus at levels that are not toxic to the mother. In addition, even if certain workplace exposures may not specifically harm fetal development, they may still harm an unborn child. For example, any health or safety hazard that introduces a health risk such as trauma or asphyxiation can be considered a threat to healthy fetal development.

Genetic Defects

Genetic defects are changes in germ cells that can be passed from one generation to the next as well as genetic problems that arise at the point of fertilization (such as Trisomy 21, the cause of Down's Syndrome). It has been estimated that at least 20% of human malformations are due to inherited genetic defects that are present in egg or sperm cells.

Non-workplace factors. Certain medications and numerous environmental chemicals are capable of producing mutations in germ cells.

Workplace concerns. Genetic defects can be caused by radiation exposures and several "genotoxic" chemicals found in the workplace.

Infertility

Infertility is defined as the inability of a couple to conceive after one year of regular intercourse without the use of contraceptives. According to ATSDR, one in twelve US couples are infertile. Hazardous exposures have been shown to cause infertility in men by interfering with hormones, damaging the testes (resulting in inability or reduced ability to produce sperm), or by directly damaging the sperm, leading to a reduction in sperm count, viability, motility, or functional capabilities. In women, lack of ovulation (release of egg) or abnormal menstruation may cause infertility. Possible causes include damage to the fallopian tubes (for example, from pelvic infections), direct damage to the egg, or a change in the balance of sex hormones (see below).

Non-workplace factors. Factors associated with infertility include a history of sexually transmitted disease, pelvic infections, substantial weight loss, thyroid and other hormonal problems, and advanced maternal age.

Workplace concerns. Examples of chemicals that have been associated with testicular damage or adverse effects on male fertility include *dibromochloropropane (DBCP), lead, carbon disulfide, carbaryl, cadmium, chlordecone, heat,* and *ethylene dibromide*.

Menstrual Disorders

Menstrual disorders due to workplace exposures have not been studied very extensively, possibly because changes in menstrual function are difficult to measure. However, any chemical that influences the balance of sex hormones could potentially cause menstrual irregularities.

Non-workplace factors. Menstrual irregularities are often due to stress, changes in diet, or heavy exercise.

Workplace concerns. Menstrual disorders have been associated with workplace exposures to *polychlorinated biphenyls (PCBs), carbon disulfide, perchloroethylene, benzene, styrene*, and *toluene*.

Impotence and Decreased Libido

Chemicals that affect the nervous system or the secretion of sex hormones have been shown to lower libido (sex drive) or alter sexual response in both men and women.

Non-workplace factors. Factors that can affect libido include fatigue, stress, illness, and some medications.

Workplace concerns. Some examples of agents with workplace data linking them to impotence or decreased libido include *synthetic estrogens*, some *solvents, carbon disulfide, manganese, mercury (inorganic),* and *vinyl chloride*.

Spontaneous Abortion

Spontaneous abortion or miscarriage is a loss of the embryo or fetus before full term. ATSDR estimates that 40 percent or more of all pregnancies end in spontaneous abortion. A spontaneous abortion can occur before a woman knows she is pregnant, so that she is only aware of a period that is late and possibly heavy. The causes of spontaneous abortions are largely unknown. In women, spontaneous abortion may be caused by:

- Damaging the genetic material in the egg so severely that the embryo cannot survive past very early stages of development,
- Preventing the fertilized egg from implanting in the uterus, and
- Directly affecting the developing embryo or fetus, causing a lethal toxic effect.

Non-workplace factors. Several factors known or suspected to be associated with an increased risk of spontaneous abortion are advanced maternal age, smoking, infection, and gynecological disorders, such as physical abnormalities of the uterus.

Workplace concerns. Some examples of exposures with workplace data linking them to increased risk of spontaneous abortion include *lead, anesthetic gases, cancer chemotherapeutic drugs, ethylene oxide, nitrous oxide, formaldehyde, arsenic, organic solvents*, and *heavy lifting*.

Stillbirths

Stillbirth is defined as birth of a dead fetus. Death occurs in late pregnancy or during birth.

Non-workplace factors. Stillbirths may be due to maternal factors, fetal factors, or uterine factors. Injuries, illnesses (such as toxemia), infections, or catastrophic events (such as hemorrhage, or cardiac arrest) would affect both mother and child. Some major birth defects and growth abnormalities in the fetus may result in fetal death. Uterine factors (such as placental detachment, placental obstruction, or restricted uterine growth) can also compromise the survival of the fetus.

Workplace concerns. Potential work-related risk factors for stillbirth include biological and chemical agents that cause birth defects (see below) and traumatic injury due to accidents or heavy lifting.

Birth Defects

A birth defect is a physical abnormality or malformation present at birth, although it may not be detected until later in life. ATSDR estimates that two to three percent of all newborns have a serious birth defect. Approximately two-thirds of human birth defects have no known cause; and the proportion of these associated with exposure to hazardous substances is unknown. Agents that cause birth defects by exposure to the embryo or fetus are called teratogens. The period of most concern is the first trimester (first three months of pregnancy), because this is when the organs and limbs are being formed. Women may not be aware that they are pregnant during much of this critical period.

Some agents can harm the fetus 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. Some examples include lead, glycol ethers, and ionizing radiation.

Non-workplace factors. Factors associated with an increased risk of birth defects are poor nutrition, advanced maternal age, alcohol consumption, maternal diseases, such as diabetes and sickle cell anemia, and some medications. Certain maternal infections such as rubella (German measles) and toxoplasmosis are known to cause birth defects.

Workplace concerns. Examples of exposures associated with increased risk of birth defects include *dioxins*, *polychlorinated biphenyls (PCBs)*, *cancer chemotherapeutic drugs*, *anesthetic gases*, *carbon disulfide*, *solvents*, and *mercury* (organic). Infectious agents, such as *cytomegalovirus*, *rubella* (German measles) and *toxoplasmosis* may be workplace hazards for health care workers, teachers, childcare workers, or animal workers.

Low Birth Weight and Premature Birth

Some agents can delay the growth or harm the health of the embryo or fetus without causing physical defects or death. The most common effect is low birth weight. Babies with very low birth weight are at increased

risk of illness or death in the first year of life. Low birth weight can also occur when a child is premature (before 37 completed weeks of gestation). In addition to being at risk for low birth weight, premature babies sometimes suffer from the effects of immature organ systems, such as the respiratory system. The factors that determine precisely when a woman goes into labor and her baby's weight are not well understood.

Non-workplace factors. Factors that have a significant adverse effect on embryonic/fetal growth and birth weight are maternal health problems, such as abnormal blood pressure, poor nutrition, smoking, alcohol use, and inconsistent prenatal care.

Workplace concerns. Increased risk of low birth weight has been associated with exposure to *carbon monoxide*, *poly-chlorinated biphenyls* (*PCBs*), *heavy physical exertion* (e.g. repetitive heavy lifting, stooping, and/or climbing), *lead*, and *methylene chloride*. Increased risk of premature birth has been associated with exposure to *polychlorinated biphenyls* (*PCBs*), *carbon disulfide*, and *heavy physical exertion* (e.g. repetitive heavy lifting, stooping, and/or climbing). See Chapter 7 for a more detailed discussion of ergonomic considerations, including heavy physical exertion.

Childhood Cancer

Cancer-causing substances (carcinogens) can affect the fetus by passing through the placenta to the fetus. These "transplacental carcinogens" can later cause cancer in the child or young adult. Although the research in this area is in its early stages, certain work environments appear to place workers at greater risk. The work environments of most concern are those in which metals, solvents, paints, and agricultural chemicals are used.

Non-workplace factors. Diethylstilbestrol (DES) was a drug given to many pregnant women in the 1950s-60s. A small percentage of their daughters developed a rare type of cancer as young adults. (There is also some evidence that a number of their sons developed abnormalities in their reproductive organs.)

Workplace concerns. An example of a transplacental carcinogen is *ionizing radiation.*

Developmental Disorders

The mental development and behavior of infants and children can be affected by their mothers' exposure to harmful substances during pregnancy. Behavioral effects include hyperactivity, decreased attention span, slow learning ability, and in severe cases, mental retardation. Such "neurobehavioral defects" can accompany physical defects, and are often not apparent at the time of birth. Some of these effects may be temporary (e.g. hyperactivity), while others are permanent (e.g. mental retardation). Exposure to toxic substances before birth is only one of many factors that affect the development and behavior of a child.

Developmental disorders are difficult to measure and have not been studied very extensively. Consequently, only a few drugs and even fewer industrial chemicals that cause neurobehavioral defects have been identified.

Non-workplace factors. Factors that have a great effect on a child's development are nutrition, genetic defects (for example, Down's Syndrome), the amount and nature of the interaction between the child and his or her parents, and the quality of the child's education. Maternal abuse of ethanol (alcohol) and narcotic drugs (e.g., cocaine, heroin) adversely affect the mental development and behavior of the developing fetus. Anticonvulsant drugs, such as hydantoin, trimethadione, and valproate have also been associated with developmental disorders in humans.

Workplace concerns. Developmental disorders have been associated with maternal exposures to *radiation*, *lead*, *carbon monoxide, polychlorinated biphenyls (PCBs)*, and *organic mercury*.

Exposure After Birth: Breast milk and carry over from work

Some toxic chemicals concentrate in fat tissue once they are absorbed into the body. Since breast milk is rich in fats, a breast-feeding infant can be exposed to these toxic chemicals. However, because breast-feeding has many positive benefits, a woman who is exposed to reproductive hazards at work should consult with her health care provider before deciding whether or not to breast feed.

Children and/or other family members can be exposed to workplace chemicals if they are brought home on skin or clothes. Adopting good personal hygiene (showering or washing at work, changing out of work clothes and shoes before going home) can prevent such exposures.

Workplace concerns. Examples of workplace agents that can get into breast milk include *polychlorinated biphenyls (PCBs*), *polybrominated biphenyls (PBBs*), *DDT* and related *chlorinated hydrocarbons, organic solvents*, *lindane*, *methylene chloride*, *phthalates*, *perchloroethylene*, *mercury*, and *lead*.

Examples of workplace agents that can be carried home on skin and clothes and affect reproduction and development include metal dusts, such as *cadmium* and *lead.*

Chapter 3:

Identifying and Evaluating Workplace Risks

Many chemical, physical, and biological agents interfere with reproduction and development in laboratory animals; however, few are known to produce similar effects in humans. This might suggest that such effects are rare or that workplace exposures are well controlled, but it could also reflect limited research in this area or difficulties involved in detecting disorders and ascribing causes in humans.

Most of the thousands of industrial chemicals in use today have not been tested for their ability to affect reproductive function and development. Similarly, the relationships between such health effects and stresses, whether physical or mental, remain unclear. 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 reduce risks to workers or to a developing fetus is to minimize or prevent exposure to suspected hazards.

Assessing Reproductive and Developmental Risks in the Workplace

Because each worker and worksite is unique, workplace risks to reproduction and development must be assessed on a case-by-case basis. This section describes a three-step risk assessment process:

- Hazard Identification,
- Exposure Assessment, and
- Risk Characterization.

This is an important tool for anyone involved in evaluating workplace hazards to reproduction and development, including health care providers, workplace health and safety personnel, and employers.

Hazard Identification

Hazard Identification is a two-step process:

1) Identifying potentially harmful chemical, physical, and biological agents; and

2) Determining whether these agents are reproductive or developmental hazards.

Identify the substance(s) used on the job.

The first step is to inventory the chemical, biological, and physical agents used on the job. This information should be available

from an employer or health & safety professional at the work site. Just having the brand name of a product is not particularly useful, because it rarely gives any indication of the actual ingredients. Sometimes a product label has ingredient information, but this information is often incomplete and unreliable. The best way to obtain information about a product's chemical composition is from a Material Safety Data Sheet (MSDS). An MSDS lists the hazardous chemical contents of a product, describes its health and safety hazards, and gives methods for its safe use, storage, and disposal. (A sample letter for requesting an MSDS and an example of an MSDS are provided in Appendix B and C, respectively.) The federal Hazard Communication Standard and the Washington State Hazard Communication Standard require manufacturers to supply an MSDS for any product that contains a certain fraction of an identified toxic substance. Employers obtain the MSDS when they purchase the product, and must make the MSDS available to employees on request. Under this standard, employers are obligated to provide a treating health care provider with this information if it is requested. In addition, product manufacturers are required to give further information on a chemical (including trade secrets and proprietary information not listed on the MSDS) to any health professional that is providing occupational health services to exposed employees.

Determine whether the agent is a reproductive or developmental hazard.

Unfortunately, MSDSs rarely include adequate information on reproductive or developmental health effects because their primary use is to identify a product's ingredients. Contacting the manufacturer directly occasionally yields useful information. In most cases, consultation with an occupational health specialist or specialized texts or databases is necessary (see "For More Information"). A good starting point is to review the lists of workplace reproductive and developmental hazards provided in this booklet. The summary tables provided in this chapter and the detailed tables provided in Appendix A list many of the most common chemical, biological, and physical hazards used in workplaces.

Testing for reproductive and developmental toxicity

Scientists use a variety of approaches to determine whether chemical, physical, or biological agents can adversely affect reproduction or development. These include studies of human populations (epidemiological studies and case studies), studies of animals, and short-term laboratory tests. Each of these methods will be described briefly below.

Human studies

Case studies are medical reports of individual cases or clusters of cases of illness, but rarely provide cause-and-effect information. Epidemiology is the study of

groups of humans to look for unusual or abnormal patterns of health problems. Epidemiological studies are designed to determine whether these unusual patterns are associated with a particular exposure.

In practice, epidemiological studies have some limitations. The principal problem is describing human exposure. Workers are usually exposed to many substances simultaneously, and it is often difficult to estimate the level of exposure to a particular substance. Therefore, determining which workplace hazards are responsible for health problems is difficult. In addition, a worker's non-occupational activities and lifestyle may involve hazardous exposures. There are also problems in describing human health effects. Harm to pregnancy or reproduction is often difficult to measure, and frequently miscarriage occurs before pregnancy is recognized. Finally, epidemiologists must study very large numbers of people to be able to detect a difference between exposed and unexposed people for rare health problems (e.g., hypospadias) or conditions that are relatively common in the general population (e.g., spontaneous abortion).

Overall, while epidemiological studies can rarely provide direct cause-and-effect information, the associations between exposure and effect that they demonstrate are useful for identifying and recognizing human reproductive and developmental hazards. However, because of the difficulties mentioned above, few agents have been well-characterized in humans.

One disadvantage in relying on epidemiological evidence is that we cannot recognize problems until they actually occur. In contrast to studies in humans, animal studies and short-term laboratory tests can serve as indicators of a potential hazard before a major problem emerges in people.

Animal studies

Standard animal reproductive and developmental toxicity tests expose groups of laboratory animals to different amounts of a suspected toxic agent for different periods of time. The timing is designed to coincide with the most sensitive exposure time for the particular effect being studied. These animals are then compared with animals that were not exposed (controls), to see if there are differences in sperm production, litter size, embryo or fetal growth and survival, birth defects in offspring, or other reproductive and developmental functions. It is usually assumed that most agents that harm reproduction or development in animals also have the potential to disturb these processes in humans.

Short-term tests

Short-term tests are laboratory methods that are relatively inexpensive and can be performed in a short period of time. The most common short-term tests are designed to determine if a substance can cause DNA mutations or chromosome breaks (changes in the genetic material of a cell). Genetic changes to germ cells could lead to sterility in the male or female or be passed on to the fetus, resulting in spontaneous abortion, genetic disease or birth defects. Other short-term tests involve culturing embryonic cells or the embryos of laboratory animals. These

tests have the advantage of being relatively inexpensive, rapid, and humane compared to animal tests. However, because they cannot mimic the very complex processes that take place in whole animals, short-term tests cannot be used by themselves to identify reproductive and developmental hazards. Nonetheless, scientists use these tests to investigate the mechanisms by which agents affect reproduction and development, screen substances for their potential toxicity, and assign priorities for animal testing.

Classifying reproductive and developmental hazards

Several schemes have been devised to categorize agents according to their potential to affect reproduction and development in humans. For the purposes of this booklet, we used the REPROTEXT® system to classify the effects of workplace agents. This computerized database describes effects on human reproduction of acute and chronic exposures to numerous substances (including chemicals commonly encountered in the workplace), as well as carcinogenic and genetic influences. This system includes a "grade-card" scale of reproductive/developmental hazards that scores the weight-of-evidence for reproductive and developmental toxicity (see below). It is critically important to recognize that the REPROTEXT® ratings do not reflect the *potencies* of the reproductive and developmental toxicants. The ratings only refer to the *weight-of-evidence* for reproductive and developmental effects in humans.

The following series of tables summarize the major reproductive and developmental hazards by the type of workplace in which they are commonly used. Since it is not possible to discuss all the agents to which workers may be exposed, we have provided a selected list of hazards that may be encountered in the workplace.

This list should be used as a starting point for discussions about reproductive and developmental hazards in the workplace. More details about these hazards are provided in Appendix A, including a

REPROTEXT® RATINGS

A+	Human reproductive hazard with no known no-effect dose.
A	Human reproductive hazard with known no-effect dose.
A–	Unconfirmed human reproductive hazard.
B+	Multiple reproductive effects in animals, no human data.
B	Mixed reproductive effects in animals but no human data.
B–	Few reproductive effects in animals but no human data.
C	No reproductive data found.
D	Insufficient information to identify.
E	Known not to affect animal reproduction but no human data.
F	Known not to affect human reproduction.

description of which specific reproductive and developmental processes are affected. Some workplace agents were not present in the REPROTEXT® database. In this case, the authors of this booklet classified these hazards based on available data. The authors' classifications are denoted by shading and assigning an asterisk (*).

It is important to note that how we view a hazard may change as the science of reproductive and developmental toxicology advances and new or better data are available.

Because this booklet focuses only on reproduction and development, other health effects of the substances in the tables are not identified or discussed. Readers are encouraged to obtain general toxicity information from other sources (see "For More Information").

CHEMICAL HAZARDS TO REPRODUCTIVE AND DEVELOPMENTAL HEALTH USED IN AGRICULTURE

Insecticides/Rodenticides/Ascaracides

Carbamates
Benomyl A–
Carbaryl A–

Organochlorines
Aldrin B+
Dichlorodiphenyltrichloroethane (DDT) A–
Dicofol B–*
Dieldrin B*
Endosulfan B+
Lindane A–
Methoxychlor B+**
Toxaphene B+

Organophosphates
Chlorpyrifos A–
Diazinon A–
Dichlorvos B
Dimethoate A–
Malathion B+
Methyl Parathion A–
Parathion B+

Pyrethrins
Resmethrin E

Rodenticides
Fluoroacetic Acid B–
Warfarin A+

Herbicides

Atrazine A–*
2,4-Dichlorophenoxyacetic Acid (2,4-D) A–
Dinoseb B+

Fungicides/Fumigants/Sterilants

Acrylonitrile A–
Benomyl A–
Bisphenol (A) C
Dibromochloropropane (DBCP) A**
Ethylene Dibromide (EDB) A–
Ethylene glycol monomethyl ether (EGME) A–
Ethylene Oxide (EtO) A–
Mercury (organic) A+
Sulfur Dioxide A–
1,1,1-Trichloroethane B
Vinclozolin B–**

Miscellaneous

Acrolein B–
Antimony Potassium Tartrate A–
Boric Acid A–
Ethylene Thiourea B**
Ortho-Dichlorobenzene A–
Perchloroethylene A–
Potassium Silver Cyanide A–
Triple Super Phosphate, Granular A–

CHEMICAL HAZARDS TO REPRODUCTIVE AND DEVELOPMENTAL HEALTH USED IN INDUSTRY

Gases
Carbon Dioxide B+
Carbon Monoxide A+
Formaldehyde A–
Methane B–
Nitrous Oxide A–
Sulfur Dioxide A–

Solvents
Acetaldehyde A–
Acetone A–
Aniline A+
Benzene A–
Carbon Tetrachloride B+
Chloroform A–
Dimethylformamide A–
Dimethyl Phthalate B
Dimethyl Sulfoxide (DMSO) B*****
Ethyl Alcohol A+
Ethylene Dibromide (EDB) A–
Ethylene glycol monoethyl ether (EGEE) A–
Ethylene glycol monomethyl ether (EGME) A–
Gasoline A–
Methanol A–
Methyl Ethyl Ketone (MEK) A–
Methylene Chloride A+
Methylformamide, N B+*****
Methylpyrrolidone B+
Ortho-Dichlorobenzene A–
Perchloroethylene A–
Phenol A+
Styrene A–
Sulfur Dioxide A–
Toluene A+
1,1,1-Trichloroethane B
Trichloroethylene (TCE) A–
Xylene A–

Metals/Metal Compounds
Aluminum A–
Antimony A–
Arsenic A–
Boron Oxide A–
Cadmium A–
Chromium B+
Copper A–
Lead A+
Manganese A–
Mercury (Inorganic) A–
Mercury (Organic) A+
Nickel B
Selenium A–
Tellurium B–
Zinc F

Miscellaneous Industrial Chemicals
Acetaldehyde A–
Acetone A–
Acrolein B–
Acrylamide B+
Acrylonitrile A–
Ammonia A–
Aniline A+
Antimony Potassium Tartrate A–
Bisphenol (A) C
Boric Acid A–
Boron Oxide A–
Bromine A–
Carbamide A–
Carbon Disulfide A+
Di(2-ethylhexyl) phthalate (DEHP) B+*****
Dimethylformamide A–
Dimethyl Phthalate B
Dinitrotoluene (DNT) A+
Epichlorohydrin B*****
Ethyl Alcohol A+
Ethylene Dibromide (EDB) A–
Ethylene Oxide A–
Ethylene Thiourea B*****
Fluoroacetic Acid B–
Gasoline A–
Lithium A–
Methanol A–
Methyl Methacrylate B–
Methylene Chloride A+
Methylformamide, N B+*****
Methylpyrrolidone B+
Paints A-
Perchloroethylene (PCE) A–
Phenol A+
Polybrominated Biphenyls (PBBs) B*****
Polychlorinated Biphenyls (PCBs) A+
Polyvinyl Chloride (PVC) A–
Potassium Silver Cyanide A–
Styrene A–
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) A–
TOCP B–
Toluene A+
Trichloroethylene (TCE) A–
Trinitrotoluene (TNT) A–*****
Vinyl Chloride Monomer (VCM) A–
Xylene A–
Zinc Chloride F

OTHER WORKPLACE HAZARDS TO REPRODUCTIVE AND DEVELOPMENTAL HEALTH

Medications

Busulfan A+
Chlorambucil A+
Cyclophosphamide A*
Diethylstilbestrol (DES) A+
Dimethyl Sulfoxide (DMSO) B*
Halothane B+**
Lithium A–
Methotrexate A+
Nitrous oxide A–
Oral Contraceptives A–*
Phenol A+
Ribavirin B+*
Warfarin A+

Ergonomic/Physical Hazards

Heat A–
Heavy Physical Exertion A**
High Frequency Electromagnetic Radiation A–**
Ionizing Radiation A
Noise A–

Biological Hazards

Cytomegalovirus A**
Hepatitis B Virus A**
Human Immunodeficiency Virus A**
Parvovirus B19, Human A**
Rubella A**
Toxoplasmosis A**
Varicella-zoster virus A**

Key to REPROTEXT® classifications:

A+ Human reproductive hazard with no known no-effect dose.
A Human reproductive hazard with known no-effect dose.
A– Unconfirmed human reproductive hazard.
B+ Multiple reproductive effects in animals, no human data.
B Mixed reproductive effects in animals but no human data.
B– Few reproductive effects in animals but no human data.
C No reproductive data found.
E Known not to affect animal reproduction but no human data.
F Known not to affect human reproduction.
***** Rating not available in REPROTEXT® database; rating applied by authors of this booklet and based on available data.

REPROTEXT® data reprinted with permission: Hall, A.H. (Ed): REPRORISK® System. MICROMEDEX, Inc., Englewood, Colorado (Volume 99, expires February 28, 1999).

Exposure Assessment: Estimating Worker Exposures to Reproductive and Developmental Hazards

Exposure routes

There are three common routes of exposure to hazardous chemicals and biological agents in the workplace:

- *Inhalation (breathing in).* Irritating chemicals, like acids and alkalis, react with the first tissue they contact in the body and can cause problems at the point of contact. Since irritants generally do not enter the bloodstream to any great extent; they are unlikely to affect other parts of the body, including the reproductive system or a developing fetus. However, other chemicals, such as waste anesthetic gases, are readily absorbed through the lungs and into the bloodstream, where they can affect the reproductive organs or the developing fetus.

- *Skin contact*. The skin is a protective barrier that prevents foreign substances from entering the body. However, chemicals such as carbon disulfide can be absorbed through the skin and enter the bloodstream. Agents can penetrate the skin more easily if the skin is cut or cracked or if a skin rash is present.

- *Ingestion (swallowing).* Chemical or biological agents can be swallowed if left on hands, clothing, or beard, or if they accidentally contaminate food, drinks, or cigarettes. Toxic agents present in the workplace in the form of dusts (for example, metal dusts like lead or cadmium) are easily ingested. Dusts and large particles too big to be absorbed in the lungs can still be captured in the nose, mouth and throat, and swallowed.

Workplace exposure limits

Although workers are potentially exposed to chemicals by all three of these routes, most occupational standards are based solely on inhalation. Airborne concentrations are expressed as milligrams per cubic meter of air (mg/m^3) or parts per million in air (ppm). Permissible exposure limits (PELs) include time-weighted averages (TWAs), short-term excursion limits (STELs), and ceiling values. These limits are for airborne concentrations designed to protect worker health (WAC-296-62: General Occupational Health Standards). However, for agents that can be easily absorbed through the skin, information on limits for the amount of skin exposure is essential.

If monitoring for airborne levels has been performed by an industrial hygienist, workers have the legal right to see the results for their work area (WAC 296-62-052).

Estimating dose

In general, the greater the amount of a substance that enters the body, the greater the likelihood, or the severity, of an effect on the individual and/or fetus. This connection between amount and effect is called the dose-response relationship.

When an individual is exposed to a toxic substance, the dose received depends on several factors:

- The level (concentration) of substance in the air.
- How hard (fast and deep) the individual is breathing, which depends on the degree of physical exertion.
- The degree of skin contact (for agents that can be absorbed through the skin, considering concentration and duration).
- The potential for ingestion through hand-to-mouth contamination.
- How easily the agent is absorbed into the bloodstream.
- How long the exposure lasts (duration).
- How often the exposure takes place (frequency).
- The adequacy of any personal protective equipment used.

Appendix D, "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. These questions are particularly useful for health care providers in eliciting a good work history.

Timing of exposure

When considering reproductive and developmental toxicity, the timing of exposure is critical. Since reproductive function in both men and women is cyclic, exposures at different times have different effects. For development, timing is critical: the same dose of the same chemical at different times may have no effect, or very different effects.

The likelihood of a chance high exposure should be considered. Is there a history of "unusual" situations, such as equipment breakdowns or spills, that may occasionally expose workers to other toxic agents or to larger amounts of agents used routinely? When considering effects on reproduction and fetal development, peak exposures may be more important than the typically measured time-weighted averages (average exposure over an entire workshift).

Evaluating symptoms

It is often difficult to determine if a worker's symptoms indicate overexposure to a substance. This is because many substances yield nonspecific symptoms. For example, solvent overexposure can mimic morning sickness. In addition, strong smells can often cause nausea in pregnant women. Several questions can help determine if symptoms are related to workplace exposures:

- Are the symptoms described consistent with the substances to which the worker is exposed?

- Does the worker feel sick at work but get better within several hours after work or over the weekend?

- For pregnant workers, did she have these symptoms at work before she got pregnant? If not, has there been some change in the work process or the chemicals she uses before attributing symptoms to the pregnancy?

When in doubt about whether symptoms reflect overexposure, occupational health specialists should err on the side of caution.

Risk Characterization

Risk Characterization involves estimating the likelihood of harm based on information gathered in the Hazard Identification and Exposure Assessment (i.e., how close is estimated worker exposure to the lowest dose that causes harm in animals or humans?).

Sometimes, assessing risk is relatively simple. For example, short-term or occasional worker exposure to low levels of substances such as paint fumes or roofing tar fumes is unlikely to affect pregnancy or fertility. In more complicated situations, it may be necessary to consult with an occupational medicine physician or other occupational health specialist.

One approach to assessing the likelihood of harm is to place the worker's exposure in one of several broad categories ("high concern," "moderate concern," "low concern" and "not of concern") based on information gathered in the Hazard Identification and Exposure Assessment. Because of the complexity of the factors that must be considered (toxicity, timing and extent of exposure, potency, severity of outcome, uncertainty inherent in animal testing, individual risk factors such as diabetes or history of miscarriage), a great deal of judgment is required when evaluating and categorizing the risk to an individual worker. The categories and the language used in this scheme are, therefore, necessarily broad.

High concern situations

This includes overexposure or substantial exposure to substances known to harm reproduction in humans (e.g., agents with a REPROTEXT® rating of A+, A, or A–).

Moderate concern situations

This includes on-going, frequent exposure to substances that are probably or possibly harmful to human reproduction based on animal evidence (e.g., agents with a REPROTEXT® rating of B+, B or B–).

Low concern situations

This includes infrequent, transient, low-level exposure to substances possibly harmful to reproduction (e.g., agents with a REPROTEXT® rating of C, E, or F).

No concern situations

This includes: 1) extremely low exposure to any toxic substance, or 2) exposure to any substance that is unlikely to be harmful to

human reproduction in the absence of severe acute overexposure (agents with a REPROTEXT® rating of C, E, or F). It should be noted, however, that these substances may have other serious toxic effects on workers that are not related to their reproductive health.

Intervention Strategies

A detailed description of intervention strategies is provided in Chapter 4. A health care professional should be involved in formulating such strategies to ensure that both the worker and unborn child are protected from exposures to reproductive and developmental hazards.

Chapter 4:

Guidance for Health Care Providers

Answering Workers' Questions

Health care providers are frequently asked about potential workplace risks to the health of men and women. While it is not the responsibility of the primary health care provider to evaluate hazards on behalf of the employer, the provider is responsible for advising patients and answering questions. A primary health care provider can also consult with an occupational medicine physician or other occupational health specialist. This chapter and the previous one are designed to help providers respond to patient concerns, independently or in conjunction with an occupational health specialist. This information is summarized in the flow-chart at the end of this chapter.

Planning the Pregnancy

Women and men may consider many aspects of their life (e.g. finances, age of other children, living arrangements) while planning for a family. Work issues should also be considered. Exposure to harmful substances is often preventable. By evaluating possible exposures at work and in the home before trying to conceive, perhaps several months before conception, people can take steps to prevent hazardous exposures and help ensure a healthy baby (see Chapter 3). Health care providers can help with this.

Evaluating Patient Risk

It is very important for the health care provider to counsel the patient regarding risk factors for adverse reproductive outcomes that are unrelated to workplace exposure. Examples of risk factors that may be more important than workplace exposures include age, lifestyle factors, and personal or family history of adverse outcomes.

The counseling and intervention for patients regarding workplace hazards vary according to the type and extent of risk in each situation. The first step, common to every case, is the process of Risk Assessment, described in detail in the previous chapter. The questionnaire for workers in Appendix D provides work history questions that can also assist in the evaluation of historical and current exposures. The health care provider may determine if there are any specific medical conditions or complications of pregnancy that might make a pregnant woman unusually susceptible to any workplace health hazard. For example, a patient with placenta previa and/or threatened abortion should be advised to limit lifting and prolonged standing. Also, a fetus that is already smaller than it should be for other reasons is at greater risk of further compromise by maternal exposure to

developmental hazards at work. Risk assessment depends on accurate identification of the relevant chemical, the timing of exposure, and the dose to which the worker is exposed.

Determining Interventions

Workplace practices may need to be modified or eliminated to control reproductive or developmental risk. Based on the results of the Risk Assessment, the provider can advise the patient on the level of risk involved and, if necessary, suggest possible interventions to reduce the risk. For example, if the Risk Assessment suggests there is little or no risk, the provider can advise the patient that there is little to be concerned about. However, if the Risk Assessment suggests a moderate or high-risk situation, the provider should advise the patient of this risk and help determine appropriate intervention(s). By working with the patient, the employer, and the labor union (if applicable), the health care provider can be instrumental in changing workplace practices and decreasing risks. This approach benefits both the patient and other employees at the worksite. Several options are available to protect "at risk" workers. They are, in order of preference:

- Reducing the level of exposure.
- Temporary transfer to a job assignment with reduced exposure to hazardous agents.
- Compensated leave and uncompensated leave.
- Quitting work.

Decisions regarding appropriate action should take into account the potential adverse impact of reductions or loss of wages or health benefits that may accompany job transfer or leave. In cases of leave or transfer, the health care provider should also consider risks to any workers who may replace the affected workers.

Reducing Exposure

Reducing exposure is the preferred alternative in any situation ("high," "moderate" or "low" concern; see Chapter 3 and the flow-chart presented at the end of this chapter). This approach has many advantages: all workers benefit; it is the least disruptive to the worker and the employer; and it does not single out reproductive hazards that may affect an individual worker or one sex more than the other.

Exposure to hazardous substances can be reduced by replacing hazardous products or processes with safer ones, improving workplace ventilation, using safe work practices, and using appropriate personal protective equipment (see Chapter 5, "Guidelines for Workplace Health & Safety Personnel"). Individual risk factors may affect selection of controls. For example, high blood pressure makes respirator use inadvisable for pregnant workers.

A visit to the worksite may be necessary, and an industrial hygienist or other knowledgeable person should be consulted.

The health care provider should inform workers that exposures can be reduced, and can help workers communicate with the employer, health and safety personnel, and the union (see "For More Information"). Some general recommendations can be made to all workers, such as storing chemicals in sealed containers when not in use; not eating, drinking, smoking or applying makeup in work areas; avoiding skin contact with chemicals; if chemicals are spilled on them, changing out of contaminated clothing right away and washing themselves with soap and water (see "How Workers Can Protect Themselves," later in this booklet).

Temporary Transfer

Economic and job security themselves are integral to workers' general and reproductive health. Consequently, job transfer is a less satisfactory alternative and must be discussed in great detail. Temporary transfer should only be recommended in high concern situations when exposures cannot, or will not, be reduced in a timely fashion. Temporary transfer should also be suggested as an option to workers in moderate concern situations. If an employee is interested, the health care provider can play an important role in helping secure temporary job transfers. Although an employer is not generally required by law to transfer a pregnant worker to a job that the worker or health care provider perceives to be safer, some employers have a policy regarding voluntary temporary transfer options during pregnancy. Many employers will follow the recommendations of a health care provider regarding job placement.

It is important to note that an employer cannot force an employee to transfer jobs. This issue was clarified in a landmark 1991 Supreme Court ruling, United Auto Workers v. Johnson Controls, in which fetal protection policies that involve mandatory transfer were forbidden.

Compensated Leave and Uncompensated Leave

While Washington State's industrial insurance laws (workers' compensation) are the usual recourse for workplace illnesses or injury, compensation is not generally available for reproductive health problems and developmental effects. A discussion of this topic is provided in Chapter 9, "Workers' Legal Rights and Responsibilities."

However, for pregnant women in high exposure situations, where exposure reduction and temporary transfer is not available, the provider should try to use the disability coverage of federal and Washington State sex discrimination laws to provide benefits for removal from hazardous exposure (see Chapter 9). While these laws do not require any employer to provide specific benefits, they state that coverage for pregnancy must be equal to coverage for any other medical conditions that temporarily interfere with ability to work. Therefore, employers must provide workers affected by pregnancy, miscarriage, or childbirth the same insurance benefits, sick leave, job modifications, seniority credits, and

reinstatement privileges afforded to workers disabled by other causes. Some workers in moderate concern situations may request disability leave if a transfer is not available.

Sometimes a pregnant worker who is exposed to a hazardous substance may not be eligible for a disability plan and find that there is no appropriate transfer available. Under these circumstances she may be eligible for unemployment compensation. Unemployment compensation is available to a worker who is involuntarily laid off because of physical inability to perform the regular work, but able and available to be hired into another job.

Quitting Work

Whether a worker decides to quit work is a personal decision. It is important that a worker be aware of the other options available and of the consequences of his or her decision.

Advising the Breast-Feeding Patient

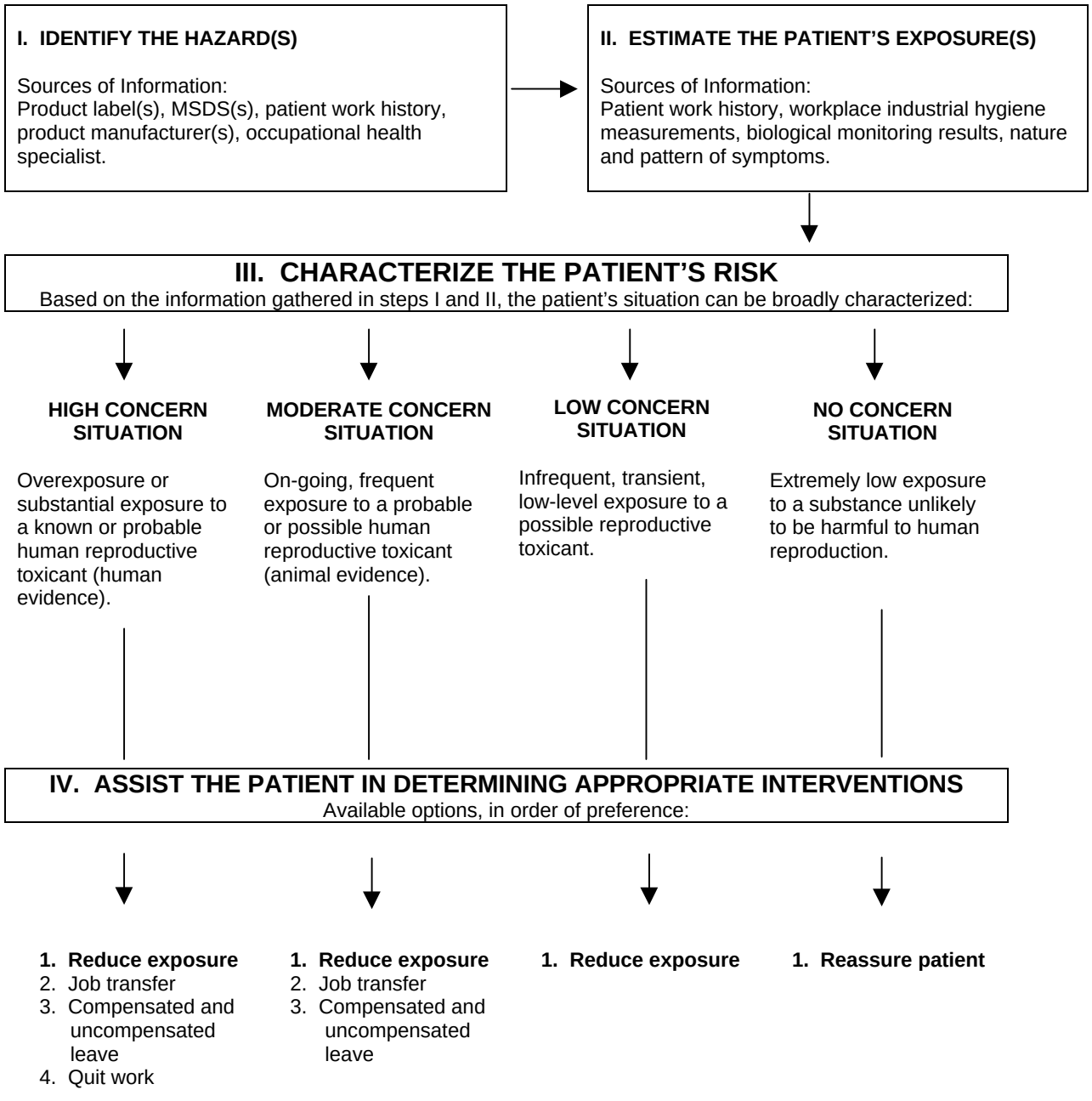
With rising numbers of women in the workplace interested in breast-feeding, concern regarding chemicals in breast milk is also growing. Some toxic substances found in the workplace can make their way into breast milk. Examples include fat-soluble volatile solvents, PCBs, PBBs, DDT, and related non-volatile chlorinated hydrocarbons.

Given the many benefits of breast-feeding, this uncertainty creates difficulties in making recommendations to women with potentially hazardous exposures.

Other Patient Concerns

This section is not exhaustive and in particular does not address the issues of counseling the pregnant patient after exposure has already occurred. For more information on addressing patient questions and concerns regarding reproductive hazards, the reader is referred to the articles by Paul & Himmelstein (1988), Welch (1986), and the computerized databases listed in “For More Information.”

RESPONDING TO PATIENT QUESTIONS REGARDING THEIR REPRODUCTIVE/DEVELOPMENTAL HEALTH AND THEIR JOB

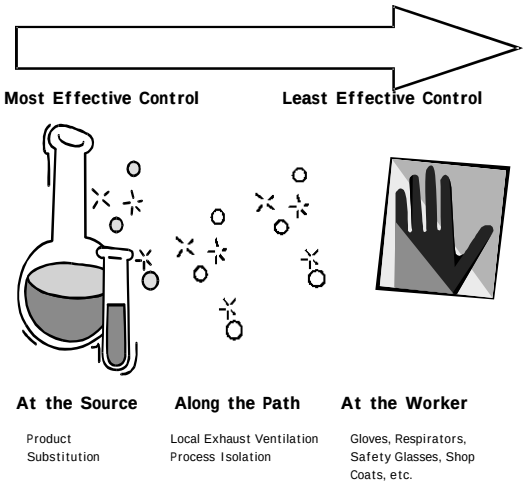


Chapter 5:

Guidelines for Workplace Health & Safety Personnel

Hierarchy of Controls

Occupational health and safety professionals refer to a "hierarchy of controls," which is a ranking of methods that can be used in the workplace to prevent or minimize worker exposures - from the most effective to the least effective. Conceptually, a workplace exposure can be visualized as a source of potentially hazardous material, and a pathway along which the hazardous material travels to reach and affect the worker. The exposures can be controlled by eliminating the source (product substitution), capturing the contaminant along the pathway (engineering controls), and finally controlling exposures at the worker (personal protective equipment, administrative controls, and personal hygiene). This ranking of controls applies to practically all workplace exposures, and is readily applicable to reproductive and developmental hazards.



Control at the Source

The most effective method of control is to eliminate exposure to reproductive or developmental hazards. This can be accomplished by substituting with a less toxic alternative. However, before a substitute is chosen, the health and safety hazards of the new product 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. Frequently, there is less information or no testing available on the new product. The substitution of one key compound may require a full evaluation of the process with modifications in work practices down the line.

Control along the Path

The goal of engineering controls is to limit exposure at the source. Types of controls are listed below in order of effectiveness:

1. 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 inside an enclosure such as a glove box.

2. Local exhaust ventilation is a hood or duct, at or above 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.

3. General or dilution ventilation is the 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.

Control at the Worker

Administrative controls

Management activities such as the institution of safe work practices, training and special policies (e.g., job rotation) can augment efforts to reduce exposure to hazardous substances. The Washington Industrial Safety and Health Act (WISHA) specifies that employers must instruct workers in general safe work practices and provide specific instructions about hazards unique to a worker's job assignment (WAC 296-24-040). More detailed information about WISHA and employer responsibilities is provided in Chapter 8.

Personal hygiene

Some general recommendations for workers handling hazardous substances are:

- Store chemicals in sealed containers when they are not in use.

- Avoid skin contact with or breathing of chemicals.

- Do not eat, drink, smoke, or apply make-up in work areas.

- Wash hands with soap and water before eating, drinking, smoking, or applying make-up.

- If chemicals spill on a worker, they must change out of contaminated clothing immediately and wash with soap and water. Separate clothing should be used at work to avoid bringing home toxic materials.

Personal protective equipment (PPE)

This final layer of control stops the exposure at the worker. Because these controls rely on workers to implement, they require greater oversight to be effective.

WAC 296-24-075 covers the use of personal protective equipment in Washington workplaces.

The following equipment can be used when engineering or administrative controls are

not feasible or are not sufficient to reduce exposure. Some workers may wish to use PPE at all times, even when engineering and administrative controls seem adequate. In light of the uncertainty surrounding so many exposures, added protection can only help, and some people may wish to err on the side of caution.

Respiratory protection

Respiratory protection involves the use of approved equipment that covers the mouth and nose and prevents substances in the air from being inhaled. A respirator is effective only when used as part of a comprehensive program established by the employer. This includes identification and measurement of concentrations of all hazardous substances, selection of the proper respirator, training the worker in its proper use, fitting the respirator to the worker, respirator maintenance and storage, replacement of parts when necessary, and a medical evaluation for workers using respirators. Minimum performance requirements for selection and use of respirators and implementation of a respirator program are provided in WAC 296-62-071, which is enforced by the Department of Labor and Industries WISHA Services Division.

Required respirator use by any worker must be evaluated by a qualified person, usually the respirator program administrator under the guidance of a physician or other appropriately licensed health care professional. If there is a change in health status, it is recommended that a health care provider be consulted about continued respirator use.

The use of a respirator by a pregnant worker, as for all workers, must also be evaluated on a case-by-case basis. Certain complications of pregnancy, such as high blood pressure, may make it inadvisable for a woman to continue working at a job that requires the use of a respirator. Several factors should be considered when the decision to use a respirator is made. All possible measures should be taken to reduce concentrations of the chemical outside the respirator (i.e., controls should be used at the source and along the path). Caution should be exercised in assigning any worker to tasks requiring the use of a respirator if a single overexposure, such as one that could result from respirator failure, could result in significant harm.

Protective clothing

Protective clothing includes gloves, aprons, goggles, boots, face shields, and any other items worn as protection. The protective clothing must be made of material designed to resist penetration by the particular toxic substance being used. Solvent-resistant gloves are particularly important, because solvents can penetrate skin as well as glove material. The manufacturer of the protective clothing usually can provide some information regarding the substances that are effectively blocked. Employers should train employees on the importance of using PPE and give them information on when the PPE should be replaced.

Chapter 6:

Responsibilities of Employers

Under the Hazard Communication Standard (WAC 296-62-054), employers are responsible for evaluating workplace hazards to reproduction and development, informing employees about these hazards, and protecting them from these hazards.

Employing an Effective Protection Program

Many large employers and labor unions have developed policies for the protection of worker reproductive and developmental health. Their experience, Washington State and federal regulatory requirements, as well as legal constraints suggest that the following features are important for an effective program.

Identification and Evaluation of Reproductive and Developmental Risks

This process involves developing a plan and the necessary resources for determining which workplace factors are potentially hazardous to reproductive and developmental health. If an employer does not have the professional staff necessary to evaluate workplace risks to reproduction, other options are available. An industrial hygiene consulting firm, an occupational health clinic, a consulting occupational medicine physician or nurse, or the Department of Labor and Industries' WISHA Services Division, Consultation Services can assist (see "For More Information").

Elimination or Reduction of Risks

If it is determined that a substance in the workplace presents a risk to worker reproductive health or embryonic/fetal development, the employer must take action to protect workers. The most desirable strategy is to eliminate the use of proven or suspect reproductive or developmental health hazards. The next preferred method is to control exposures to acceptable levels for ALL employees. Where technical difficulties, economic constraints and/or scientific uncertainty make elimination impossible, a combination of engineering controls and, when necessary, personal protective equipment may be employed (see Chapter 5, "Guidelines for Workplace Health and Safety Personnel").

Job Rotation or Transfer

If exposure cannot be reduced in a timely or satisfactory manner, the worker at risk could be voluntarily transferred to a job that does not involve exposure to hazardous chemicals or activities. In most cases, this transfer can be temporary, and should include retention of salary, protection of seniority and benefits, and the right to return to the original or a substantially similar job.

Orientation and Information Sessions

This educational approach serves to alert employees to potential hazards on the job and provides an introduction to the elements of the reproductive hazard protection program and instruction on protective measures (e.g., equipment and hygiene).

Specifically, the required elements of the employer's Hazard Communication Program under the Standard include:

Information

All employees must be informed of:

- The Hazard Communication Standard requirements,
- Any operations in their work areas that involve hazardous chemicals, and
- The location and availability of the written Hazard Communication Program, including the list(s) of hazardous chemicals and material safety data sheets (MSDS).

Training

Employees who are exposed or potentially exposed must be trained about:

- How they can detect the presence or release of hazardous chemicals;
- Physical and health risks including reproductive and developmental hazards of chemicals in the work area;
- How they can protect themselves through work practices, emergency procedures and personal protective equipment; and
- Details of the Hazard Communication Program. This should include an explanation of any labeling system, material safety data sheets and instructions on how to obtain and use hazard information.

Exposure Monitoring

If known or suspected hazards exist, employers may attempt to implement medical surveillance programs in order to monitor worker exposure levels. Some standards require medical monitoring. Such programs ensure that individual workers are not exposed to harmful levels of specific agents and enable timely intervention to prevent health problems. Some difficulties with exposure monitoring include technical infeasibility, financial burden, intrusiveness, and scientific uncertainty regarding threshold exposure levels and degree of hazard for specific agents. The American Conference of Government Industrial Hygienists (ACGIH) has published biological exposure indices (BEIs) for substances for which biological monitoring has been developed and validated.

Counseling Service

Counseling is designed to offer individual job assessment and recommendations to workers who intend to have children and are concerned about specific agents in the workplace. Counseling regarding appropriate work activities may be offered directly from the employer's health and safety staff. Primary health care providers and non-medical safety staff often are not well-informed about reproductive and developmental hazards. Consequently, it may be preferable to consult with a toxicologist, occupational medicine physician, or other professional with expertise in this area for counseling.

Avoiding Discriminatory Policies

Any policies or actions taken by the employer must not violate existing laws prohibiting sex discrimination. Options for managing risk must be carefully considered before taking action. For example, failure to use a feasible alternative with the least adverse impact on the affected sex (such as reducing or eliminating exposure) may constitute sex discrimination. For more information on the law against discrimination, see Chapter 8.

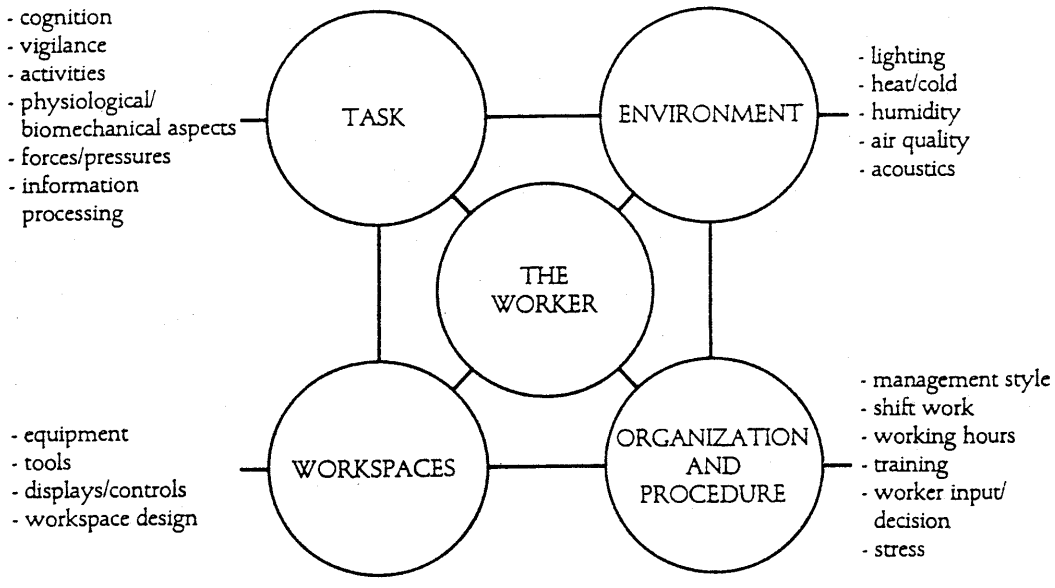
Chapter 7:

Focus on Selected Hazards

This section provides brief descriptions of topical issues in reproductive and developmental health. The purpose of this section is to provide background information on potential hazards, so that concerned employers, workers, health & safety personnel, and health care providers can find additional information.

Ergonomic Considerations

Ergonomics is "the scientific study of human work." The term comes from the Greek words "ergos" meaning work, and "nomos," meaning natural laws. All the physical and psychological aspects of the work environment are considered ergonomic factors and are summarized in the figure below:



Source: Alberta Worker's Health Center - Occupational Ergonomics

Problems may arise when any of the above factors, alone or in combination, place extreme demands on the worker. Solutions can often consist of fitting the job to the worker instead of the worker to the job. The result is most often worker comfort, increased morale and productivity, a reduction in musculoskeletal disorders, and a decrease in human and monetary costs.

Are these ergonomic factors harmful to reproduction and development?

Awkward posture, high stress, heavy or repetitive lifting, long working hours, shift work, night work, and standing for long periods of time have all been studied in regard to reproductive and developmental outcomes. Prolonged standing, heavy lifting, and physically strenuous work have been studied most often. These types of stressful working conditions have been associated with spontaneous abortion, premature delivery (before the 37th week gestation), and low birth weight infants. Studies suggest that the effect of physical stressors is greatest during the third trimester of pregnancy and scientific evidence is strongest for an association between physically stressful work and premature delivery. The evidence is not conclusive on which or how many workplace stressors place a woman at risk for premature delivery. However, it is thought that the types of stressors are not as important as the number of stressors encountered. For example, some jobs may involve standing for eight hours, working rotating shifts, and lifting heavy boxes. The combination of these stressors is thought to be of greater concern than any one by itself.

How can work-related physical and organizational stressors be harmful to reproduction and development?

Employment itself is not a risk factor for adverse reproductive and developmental outcomes. In fact, outcomes are as favorable, or better, in employed individuals. This is because they have the advantages of wage earning, access to medical care, and the fact that they are healthy enough to work in the first place. Nonetheless, some outcomes such as low birth weight and premature birth have been associated with high or strenuous physical activity at work. It is important to remember that physical activity promotes good health during pregnancy. However, excessive physical exertion may affect hormone balance, blood flow to the uterus, and pressure within the abdomen. It may also further increase caloric needs at a time when needs are already increased.

The factors important in determining precisely when a woman goes into labor and her baby's weight are not well understood. Fetal birth weight depends upon how far along the woman is in her pregnancy and how well blood and nutrients are flowing through the placenta. Low birth weight (less than 2500 grams or 5.5 pounds) is a major risk factor for infant illness and death. Standing may affect development by restricting the mother's blood circulation. Lifting and heavy exertion may produce increased abdominal pressure. Both of these results may endanger fetal circulation and lead to early birth and low birth weight.

What can we do?

The first step should be an evaluation of the work environment. The figure above and the "Estimating Workplace Exposure" questionnaire (in Appendix D) may be useful in this regard. Next, the worker and employer should work together to make any necessary modifications in workplace layout, work posture, and work techniques. If necessary, an ergonomist can be consulted to evaluate the work situation and provide suggestions for a safe and comfortable work environment.

The best outcomes are achieved when the pregnant woman is given the ability to control her work pace and workplace layout. Controlling the pace of her workplace activities is actually more important than the tasks themselves. She should be given the opportunity to take rest breaks as needed. The time spent sitting and standing should be varied so that she is not doing either for a prolonged amount of time. A change every hour is desirable.

Decreased workload, safety training, lighter duty, fewer hours, or temporary job reassignments are some other options. However, jobs that require climbing ladders, balance, carrying bulky weight, or repetitive lifting should be discouraged. Furthermore, any weight carried should be limited to a weight near the woman's pre-pregnancy weight limit. (Note: NIOSH suggests that the majority of the non-pregnant female population is capable of lifting 50 pounds safely if the load is kept close to the body and at waist height and if the load is not lifted repetitively or with a twisted or bent posture.)

Although the evidence is not conclusive, it is wise to evaluate the working conditions of pregnant workers employed in physically stressful jobs. Throughout the process, communication between the employer, the pregnant worker, and her health care provider is important. Once this is done, adjustments can usually be made to assure continued safe employment during the third trimester of pregnancy

Job modifications to help make the pregnant worker more comfortable:

Problem: Low back pain
Possible solutions: Provide a work surface suitable for sitting or standing. This could include a high chair and a high workbench. The ability to select the height of the work surface minimizes changes in posture that may lead to musculoskeletal complaints. Provide a chair with a backrest to support the lumbar and sacral areas. Provide a footrest to reduce pressure. Provide a step stool to elevate one foot while standing, reducing back sway.

Problem: Edema
Possible solutions: Allow short breaks each hour so that the worker can stretch and walk. Modify work position by providing an adjustable chair or workstation.

Problem: Standing
Possible solutions: Allow short breaks each hour so that the worker can stretch and walk. Modify work position by allowing periodic horizontal positions (raise legs, recline back).

Problem: Increased frequency of urination because pregnancy affects the kidneys and places increased pressure on the bladder.
Possible solutions: Sufficient opportunities for bathroom breaks are very important for the comfort of the woman.

Problem: Hunger and nausea
Possible solutions: The hunger and nausea experienced by pregnant women may be reduced by allowing a few minutes for a snack. In addition, failure to take in enough calories may prevent proper weight gain by mother and baby.

Problem: Fatigue
Possible solutions: Make sure the workstation fits the worker. Decrease work loads or increase work breaks.

For More Information on Ergonomics

"Physical Work Load and Pregnancy Outcome," G. Ahlborg, in: *Journal of Occupational and Environmental Medicine* 37(8), 941-944, 1995.

"Pregnant Workers: A physician's guide to assessing safe employment," J.S. Feinberg and C.R. Kelley, in: *Western Journal of Medicine* 168(2), 86-92, 1998.

"Ergonomics," M. Marbury, in M. Paul, ed. Occupational and Environmental Reproductive Hazards: A Guide for Clinicians, Williams and Wilkins, Baltimore, pp.201-217, 1993.

"Revised NIOSH Lifting Equation," National Institute of Occupational Safety and Health, United States Department of Health and Human Services, Centers for Disease Control, Cincinnati, Ohio, 1991. DHHS (NIOSH) Publication No. 94-110.

"Shift work and reproductive health," T. Nurminen, in: *Scandinavian Journal of Work, Environment and Health* 24 (supplement 3), 28-24, 1998.

"Work load and musculoskeletal complaints during pregnancy," J. Paul, F.J.H. van Dijk, and M.H.W. Frings-Dresen, in: *Scandinavian Journal of Work, Environment and Health* 20(3), 153-159, 1994.

"Work Pace Control and Pregnancy Health in a Population-based Sample of Employed Women in Norway," E. Wergeland and K. Strand, in: *Scandinavian Journal of Work, Environment and Health* 24(3), 206-212, 1998.

Video Display Terminals

There has been a great deal of controversy concerning the role of video display terminals (VDTs) in increasing the risk of birth defects, miscarriages, or other reproductive problems amongst women of childbearing age. Much of the debate was fueled by media reports in the early 1990s that drew attention to possible health hazards from electromagnetic fields (EMFs) emitted by VDTs. The following summary is based on a publication by the March of Dimes Birth Defects Foundation, entitled "VDT Facts."

Radiation and Birth Defects

Studies by NIOSH in the early 1980s determined that VDTs do not emit detectable levels of X-rays, a form of radiation that is known (in high doses) to cause birth defects. While VDTs do produce X-rays, this form of radiation is absorbed within the terminals. These studies were prompted when several small "clusters" of miscarriages and birth defects were reported by women who used VDTs during pregnancy. Speculation ensued that VDTs might emit harmful levels of radiation, like some pre-1970 color TV sets that leaked worrisome amounts of X-rays. Other studies further discounted radiation risks to the fetus. In the clusters of birth defects among co-workers, the birth defects were of different kinds, and so did not seem to reflect any single cause. In addition, these birth defects were not of the kinds typically caused by high-level radiation exposure. Most experts believe the best explanation for these apparent clusters is chance.

Controversy Continues

VDTs emit another form of energy called an electromagnetic field (EMF). Power lines, common household wiring and electric appliances also produce EMFs. Unlike X-rays, EMFs do not kill cells or damage genes, and have long been considered safe. Scientists are now taking a closer look at possible health effects of EMFs since two studies in Denver suggested that children who live near high-current electric power distribution wires had a one-and-a-half to two-fold greater risk of cancer, especially leukemia, than other children. The U.S. Congress's Office of

Technology Assessment has reported that low frequency EMFs can interact with individual cells to produce certain biological changes. However, the significance of these changes is not known - and it is far from clear that exposure to EMFs pose a risk to pregnant women, their babies or anyone else.

Some scientists feel that the possible health risks from exposure to strong EMFs have been greatly exaggerated, whereas others believe that potential health effects cannot be discounted until we learn more about how this form of energy may affect our bodies.

VDTs and Pregnancy Outcome

In 1991, a study by NIOSH - considered one of the largest and most detailed studies of this issue to date - reported that women who work at VDTs all day have no more risk of miscarriage than women with similar jobs who do not use VDTs. Most studies of the possible risks of VDTs in pregnancy have produced similar results.

This study helps to ease concerns raised by a 1988 study by researchers at Northern California Kaiser-Permanente Medical Care Program who reported an almost doubled risk of miscarriage among women in clerical positions who used VDTs for 20 or more hours per week. However, there was no increase in the number of miscarriages among women in professional jobs who used VDTs for the same number of hours. The different results for professional and clerical workers suggest that the VDTs themselves were not responsible for the observed increase in miscarriages in that study.

The NIOSH study also reported that pregnant VDT users were exposed to electromagnetic energy at levels no higher than those experienced in the home. While additional studies on the use of VDTs during pregnancy are under way, *current evidence suggests that VDTs are safe to use during pregnancy*.

A 1997 study by NIOSH compared risk of reduced birth weight and premature birth among telephone operators who use VDTs at work compared to non-VDT-users. Following interviews with 2,430 women, NIOSH concluded that *working with VDTs does not increase a woman's risk of delivering a baby of reduced birth weight or delivering prematurely.*

Other Health Concerns

Many VDT workers complain about neck, back, wrist, hand and shoulder pain - which doctors sometimes refer to as repetitive strain injury - as well as eye strain. Psychological stress is also frequently reported; and some studies have suggested that high levels of stress may adversely affect pregnancy.

Controlling Exposures

Pregnant women who are concerned about EMFs can minimize their exposure by sitting an arm's length away from the front of the computer screen. The strength of VDT EMFs drops off quickly after about 24 inches. Neither lead aprons nor any other type of radiation shield stops EMFs.

Many of the other physical and psychological stresses of VDT work can be eliminated or reduced by appropriately timed work breaks and good workplace design. VDT operators often spend hours without moving from their chairs. This can lead to tense muscles and poor circulation - which can make a pregnant woman especially uncomfortable. The continuous stress on wrists and arms can result in inflammation of tendons, which may pinch nerves to cause numbness and pain.

Detachable keyboards and height-adjustable tables and chairs can help prevent neck, back, and arm discomforts. A chair should also provide support for the lower back. The computer screen should be located at or just below eye level to help reduce neck and back problems. Flexibility is key; workers should not have to adjust their bodies to fit VDTs.

Glare from screens and close viewing without breaks contribute to eyestrain. Screens made of non-reflective glass, adjustable screen light and contrast, and installation of indirect lighting can help alleviate eyestrain.

Exercise breaks of fifteen minutes for every hour or two of VDT use are recommended. A brisk walk or body stretching decreases fatigue and increases productivity. Between breaks, inconspicuous exercises at the computer terminal can help - shoulder shrugs, head rolls and foot rotations help keep blood circulating, muscles relaxed.

For More Information on VDTs

"VDT Facts." Published by March of Dimes Birth Defects Foundation. December, 1992. Publication 09-410-00. Available on the World Wide Web at *http://modimes.org/pub/vdt.htm.*

Grajewski, B. et al. " Work with Video Display Terminals and the Risk of Reduced Birthweight and Preterm Birth." *American Journal of Industrial Medicine* 32:681-688, 1997.
Report of the 1997 NIOSH study.

Marcus, M. "Epidemiologic Studies of VDT Use and Pregnancy Outcome." *Reproductive Toxicology* 4:51-56, 1990.

Schnorr, T.M. et al. "Video Display Terminals and the Risk of Spontaneous Abortions." *New England Journal of Medicine* 324:727-733, 1991.
Report of the 1990 NIOSH study.

Scialli, A.R. "The History of Concerns about VDTs." *Reproductive Toxicology* 4:43-44, 1990.

Endocrine Disruptors

Recently, a great deal of attention has been paid to the potential hazards of certain chemicals that disrupt the endocrine system. These chemicals have been called "endocrine disruptors" because they are thought to mimic natural hormones, inhibit the action of hormones, or otherwise alter the normal regulatory function of the immune, nervous, and endocrine systems. Most of the scientific and popular literature has focused on the environmental impacts of endocrine disruptors. However, workers in a variety of industries could be exposed to higher levels of these substances than would be found in a non-workplace environment.

It is beyond the scope of this booklet to provide a comprehensive review of this controversial subject. The interested reader can find more articles on endocrine disruption in "For More Information on Endocrine Disruptors." Much of the material presented in this section was adapted from EPA's "Special Report on Endocrine Disruption."

Background on the Endocrine System

The endocrine system helps guide development, growth, reproduction, behavior and other bodily functions of animals and humans. It is comprised of endocrine glands and hormones. Some of the major endocrine glands are the pituitary, thyroid, pancreas, adrenal, and the male and female gonads (testes and ovaries). Endocrine glands produce hormones and secrete them directly into the bloodstream. Hormones act as chemical messengers, traveling through the blood to distant tissues and organs, where they can bind to specific cell sites called receptors. By binding to receptors, hormones trigger various responses in the tissues containing the receptors.

An endocrine disruptor is an external agent that interferes in some way with the role of natural hormones in the body. An agent might disrupt the endocrine system by affecting any of the various stages of hormone production and activity, such as by preventing the synthesis of hormones, by directly binding to hormone receptors, or by interfering with the natural breakdown of hormones.

Health Effects

Compelling evidence has accumulated that the endocrine systems of certain fish and wildlife have been disturbed by chemicals that contaminate their habitats. Whether this endocrine disruption is confined to isolated areas or is representative of more widespread environmental conditions is not clear at present. Groups of organisms for which there is much evidence of endocrine disruption include snails, oysters, fish, alligators and other reptiles, and birds, such as gulls and eagles.

A variety of chemicals have also been found to cause endocrine disruption in laboratory mammals. Observed effects have included disruption of female and male reproductive function (such as disruption of normal sexual differentiation, development of the reproductive system, ovarian function, sperm production, and pregnancy) and effects on the thyroid gland (which helps maintain normal metabolism). Examples of chemicals proposed to have effects on the reproductive and endocrine systems (from Colborn et al., 1993) include:

- **Pesticides**
  - *Herbicides.*
    2,4-D, 2,4,5-T, Alachlor, Amitrole, Atrazine, Metribuzin, Nitrofen, Trifluralin
  - *Fungicides.*
    Benomyl, Hexachlorobenzene, Tributyl tin, Mancozeb, Zineb, Maneb, Ziran, Metiram-complex
  - *Insecticides.*
    β-HCH, Carbaryl, Chlordane, Dicofol, Dieldrin, DDT and metabolites, Endosulfan, Heptachlor, and Heptachlor epoxide, Lindane (γ-HCH), Methomyl, Methoxychlor, Mirex, Oxychlordane, Parathion, Synthetic pyrethroids, Toxaphene, Transnonachlor
  - *Nematocides.*
    Aldicarb, DBCP

- **Industrial Chemicals**
  Cadmium, Dioxin (2,3,7,8-TCDD), Lead, Mercury, PBBs, PCBs, Pentachlorophenol, Penta- to nonylphenols, Phthalates, Styrenes

Some scientists suggest that the effects seen in laboratory studies may also be occurring in human beings. However, there is considerable scientific debate on this issue. With the single exception of diethylstilbestrol (DES), many scientists contend that there is no evidence of cause-and-effect relationships between endocrine disruption and adverse health effects in humans.

Clearly, a great deal of research is needed to determine the contribution of endocrine disruptors to reproductive and developmental health problems in both the environment and the workplace.

Controlling Exposures

Although relatively little information is available on the importance of endocrine disruptors in the workplace, the goal for employers and workers should be to reduce exposures to these substances as much as possible. This is the surest way to prevent endocrine disruptors from harming workers or the fetus.

For More Information on Endocrine Disruptors

"Special Report on Environmental Endocrine Disruption: An Effects Assessment and Analysis." US EPA. Report# EPA/630/R-96/012. February 1997. Available on the World Wide Web at *http://www.epa.gov/ORD/WebPubs/endocrine/*

"EPA Special Report On Endocrine Disruption." US EPA. February 1997. Available on the World Wide Web at *http://www.epa.gov/ORD/WebPubs/endocrine/*

Colborn T, vom-Saal FS, Soto A M. (1993). "Developmental effects of endocrine-disrupting chemicals in wildlife and humans." *Environmental Health Perspectives*, 101(5), 378-84.

Colborn T, Dumanoski D, Myers JP, eds. "Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story." Dutton Books, New York, 1996

"Reproductive Hazards." OSHA Fact Sheet. Available on the World Wide Web at *http://www.osha.gov/oshinfo/priorities/reproductive.html*

"Environmental Estrogens and Other Hormones." Center for Bioenvironmental Research of Tulane and Xavier Universities. Available on the World Wide Web at *http://www.tmc.tulane.edu/cbr/ECME/EEHome/default.html*

Safe SH. "Environmental and dietary estrogens and human health: is there a problem?" *Environ Health Perspect* 103:346-351, 1995.

Cooper RL and Kavlock RJ. "Endocrine disruptors and reproductive development: a weight-of-evidence overview." *Journal of Endocrinology (1997) 152, 159–166.* Available on the World Wide Web at *http://journals.endocrinology.org/joe//152/joe1520159.htm*

Chapter 8:

Workplace Regulations

In 1973, the Washington Legislature enacted the Washington Industrial Safety and Health Act (WISHA) with the goal to assure "safe and healthful working conditions for every man and woman working in the State of Washington." The Department of Labor and Industries has adopted many regulations to protect workers' safety and health. These regulations are found in Title 296 of the Washington Administrative Code (WAC).

The Department's WISHA Services Division regulates workplace safety and health, which includes workplace exposure to chemicals and other reproductive hazards. Some of the important regulations that touch on potential hazards to reproductive health and development are identified in previous chapters. A few more are summarized below.

Hazard Communication Standard

The Hazard Communication Standard (WAC 296-62-054) 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 capabilities. Employers are also required to have an MSDS for any workplace product that contains a hazardous substance and must make the MSDS available to workers and to a treating physician on request. The MSDS must include information about any reproductive or developmental effects of the substance. Unfortunately, this information is often not complete.

Permissible Exposure Limits

Department regulations establish Permissible Exposure Limits (PELs) (mostly in WAC 296-62-075). These are airborne concentrations of substances that represent enforced limits for regularly exposed workers (5 days/week, 8 hours/day). These limits are intended to represent the maximum amount (concentration) of a chemical that can be present in air without presenting a health hazard, and often employers are able to keep air concentrations well below the PEL. However, exposure limits are not always completely protective. For example, skin exposure is not addressed, and the majority of PELs do not take adverse reproductive and developmental effects into account. In fact, to date only three chemicals are regulated partially on the basis of reproductive risk: lead, ethylene oxide, and dibromochloropropane. The Occupational Safety and Health Administration (OSHA) is due to add glycol ethers to the list in 2000. OSHA may establish lower PELs that consider reproductive hazards.

Personal Protective Equipment

Employers are required to provide protective clothing and other equipment when necessary (WAC 296-24-075). The selection of appropriate protective equipment is a complex task. An industrial hygienist, safety professional, or other knowledgeable person should be consulted to ensure that the equipment is appropriate and used correctly, particularly for pregnant workers (see Chapter 5).

Safety and Health Committee

Workplaces with eleven or more employees must designate a safety committee composed of employer-selected and worker-elected members (WAC 296-24-045) and maintain a written accident-prevention program (WAC-296-24-040). The committee is responsible for reviewing health inspection reports, accident investigations, and illness/injury prevention programs to assist in ensuring safe workplace conditions. At a minimum, the accident prevention program should consist of a safety orientation program describing the employer's safety program and a designated safety and health committee consisting of management and employee representatives. The employee representatives are elected or appointed by fellow employees.

Other Regulations

Other relevant WISHA regulations that are designed to protect the health of Washington State workers include:

- Respiratory Protection (WAC 296-62-071)
- Biological Agents (WAC 296-62-080)
- Bloodborne Pathogens (WAC 296-62-08001)
- Hazardous Chemicals in Laboratories (WAC 296-62-400)
- Control of Chemical Agents (WAC 296-62-07005)
- Physical Agents (WAC 296-62-090)
  - Ionizing radiation
  - Nonionizing radiation
  - Temperature, radiant heat, temperature-humidity conditions

For more information about WISHA regulations, contact the nearest office of the Washington State Department of Labor and Industries (see “For More Information”) or visit WISHA’s World Wide Web site at *http://www.wa.gov/lni/wisha.*

Chapter 9:

Workers' Legal Rights and Responsibilities

If you are concerned about a safety or health hazard in your workplace, you have the right to file a confidential complaint with WISHA by calling the safety and health hotline at 1-800-4BE-SAFE (1-800-423-7233) or the nearest office of the Washington State Department of Labor and Industries (see "For More Information"). If you are comfortable doing so, you may also choose to bring your concern to your employer's attention directly, in order to give them the opportunity to rectify the problem without involving WISHA.

As more is learned in the scientific and medical communities about reproductive and developmental hazards in the workplace, additional legal protection will likely become available to workers. While Washington State's industrial insurance laws (workers' compensation) are the usual source of compensation for lost wages due to workplace illness or injury, there are a number of limitations that make benefits for reproductive and developmental health effects virtually impossible.

First of all, it is seldom possible to prove that a work exposure directly caused reproductive impairment or a poor pregnancy outcome. In addition, reproductive problems like sterility are not covered by the workers' compensation plan because they do not interfere *directly* with ability to work. Finally, only "personal" injuries of the worker are covered, thereby excluding recovery for harm to a worker's fetus or child caused by parental exposure. In situations where all criteria are met, workers' compensation generally reimburses documented medical expenses and provides lost time payments in place of lost wages.

Another aspect of workers' compensation that is particularly restrictive is the "exclusive remedy" doctrine. This specifically prohibits workers from suing employers for a job-related illness or injury. Other legal options for dealing with reproductive hazards exist, and the worker should consult an attorney if considering a lawsuit.

Workers have some additional rights from state and federal discrimination laws. The following is a summary of a few of the important laws.

Laws Against Discrimination

Under WISHA, an employer is prohibited from discriminating against an employee in any manner for filing a workplace safety or

health complaint with the Department of Labor and Industries or for exercising any other right afforded by WISHA, such as requesting an MSDS (see Chapter 8, "Workplace Regulations") or refusing dangerous work.

The right to refuse to do a task is protected if *all* of the following conditions are met: (1) the concern about safety is genuine and not a disguised attempt to harass the employer or the employer's business; (2) there is a real danger of death or injury if the job is performed; *and* (3) there is not enough time, due to the urgency of the hazard, to get it corrected through regular enforcement channels.

When all of these conditions are met, a worker should first try to (1) ask the employer to correct the hazard; (2) ask the employer for other work; (3) tell the employer that he or she will not work unless the hazard is corrected; and (4) remain on the worksite until ordered to leave by the employer.

Even when all of these conditions are met, an employer may still fire a worker refusing unsafe work. In practice, the legal and administrative effort for a worker to win such a discrimination charge is very great.

A complaint alleging discrimination must be filed within 30 days after the discrimination (RCW 49.17.160). This may be done with the Assistant Director of WISHA; the Legal Services Program, Investigations Unit (360-902-5480); or by contacting the nearest office of the Washington State Department of Labor and Industries (see "For More Information"); or calling *1-800-LISTENS*.

Sex discrimination in employment is unlawful under Washington law (RCW 49.60.030 [1] [a]) and under the federal Civil Rights Act. The U.S. law applies to all workplaces with 15 or more employees. These laws establish that discrimination against women on the basis of pregnancy is sex discrimination and is illegal. An employer cannot refuse to hire, assign or promote a woman because she is or may become pregnant. The U.S. Supreme Court issued a decision in 1991 that confirms this in United Auto Workers v. Johnson Controls. These laws also state 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 different treatment. For example, workers with heart problems may be given job transfers to light duty or put on temporary disability status. Workers with a pregnancy-related disability must be treated with the same regard and given the same options. A worker who believes that they have been discriminated against on the basis of sex may file a complaint with the State Human Rights Commission or the local office for the federal Equal Employment Opportunities Commission (see "For More Information").

How Workers Can Protect Themselves

Employers are responsible for training and protecting their workers. However, since so little is known about reproductive and developmental hazards, workers should also take the following steps to ensure their own safety:

- Store chemicals in sealed containers when they are not in use.
- Wash hands after contact with hazardous substances and before eating, drinking, or smoking.
- Avoid skin contact with chemicals.
- If chemicals contact the skin, follow directions for washing provided in the material safety data sheet (MSDS). Employers are required to have copies of MSDSs for all hazardous materials used in their workplace and to provide them to workers upon request.
- Review all MSDSs to become familiar with any reproductive or developmental hazards used in your workplace. If you are concerned about reproductive hazards in the workplace, consult your health care provider.
- To prevent home contamination:
  - ✓ Change out of contaminated clothing and wash with soap and water before going home.
  - ✓ Store street clothes in a separate area of the workplace to prevent contamination.
  - ✓ Wash work clothing separately from other laundry (at work if possible).
  - ✓ Avoid bringing contaminated clothing or other objects home.
- Participate in all safety and health education, training, and monitoring programs offered by your employer.
- Learn about proper work practices and engineering controls (such as improved ventilation).
- Use personal protective equipment (i.e., gloves, respirators, and personal protective clothing) to reduce exposures to workplace hazards.
- Follow your employer's safety and health work practices and procedures implemented by your employer to prevent exposures to reproductive hazards.

Adapted from: *The Effects of Workplace Hazards on Female Reproductive Health*, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department Of Health & Human Services, DHHS (NIOSH) Publication No. 99-104, 1999.

Conclusions

It is important to remember that exposure to toxic agents is only one of many factors that can harm reproduction and result in poor pregnancy outcomes. Although much is still unknown about the extent to which workplace hazards contribute to these health problems, hazardous workplace exposures are generally preventable. Therefore, the goal for employers and workers should be to reduce exposures as much as possible. This is the surest way to prevent toxic exposures from harming workers or the fetus.

For More Information

Workplace Issues

The Washington Industrial Safety and Health Act (WISHA) is administered by the Department of Labor and Industries through the WISHA Services Division. This division is responsible for adopting, developing, and enforcing health and safety standards; educating employers and employees; and ensuring compliance with safety and health laws. Employers have the responsibility to provide a safe workplace for their employees. Through fulfillment of these duties, the health and safety of workers is protected.

Compliance Program

Employees who need information or assistance concerning workplace health and safety regulations, or who want to file a complaint, should contact the nearest office of the Washington State Department of Labor and Industries. The service locations are listed in the table on the following page.

Consultation Program

Employers who want free assistance to evaluate and improve workplace health and safety should contact the nearest office of the Washington State Department of Labor and Industries. The department offers free consultation services to all employers without threat of fines or penalties for non-compliance. The service locations are listed in the table on the following page.

In addition, the University of Washington provides free industrial hygiene and safety evaluation and consultation for interested employers throughout the State of Washington.

Field Research and Consultation Group
Department of Environmental Health
Box 354659
University of Washington
4225 Roosevelt Way NE
Seattle, WA 98105
Telephone: (206) 543-9711
FAX: (206) 543-1740

Labor & Industries Service Locations		
Aberdeen Telephone: (360) 533-8200 FAX: (360) 533-8220 TDD: (360) 533-9336 415 West Wishkah, Suite 1B Aberdeen, WA 98520-0013	**Longview** Telephone: (360) 575-6900 FAX: (360) 577-5461 TDD: (360) 577-5428 900 Ocean Beach Hwy Longview, WA 98632-4013	**Tacoma** Telephone: (253) 596-3800 FAX: (253) 596-3956 TDD: (253) 596-3887 1305 Tacoma Avenue S, Suite 305 Tacoma, WA 98402-1988
Bellevue Telephone: (425) 990-1400 FAX: (425) 990-1446 TDD: (425) 637-5450 616 120th Avenue NE, Suite C201 Bellevue, WA 98005-3037	**Moses Lake** Telephone: (509) 764-6900 Claims/industrial insurance - (509) 764-6912 Electrical - (509) 764-6900 FAX: (509) 764-6923 TDD: (509) 754-6030 3001 W. Broadway Ave. Moses Lake, WA 98837-2907	**Tukwila** Telephone: (206) 248-8240 FAX: (206) 248-8296 TDD: (206) 248-8245 PO Box 69050 12806 Gateway Drive Seattle, WA 98168-1050
Bellingham Telephone: (360) 647-7300 FAX: 647-7310 TDD: (360) 647-7299 1720 Ellis Street, Suite 200 Bellingham, WA 98225-4600	**Mount Vernon** Telephone: (360) 416-3000 FAX: (360) 416-3030 TDD: (306) 416-3072 525 E College Way, Suite H Mount Vernon, WA 98273-5500	**Tumwater** Telephone: (360) 902-5799 FAX: (360) 902-5792 TDD: (360) 902-4637 1st Floor, Lobby PO Box 44851 7273 Linderson Way SW Olympia, WA 98504-4851
Bremerton Telephone: (360) 415-4000 FAX: (360) 415-4047 TDD: (360) 415-4014 500 Pacific Avenue, Suite 400 Bremerton, WA 98337-1904	**Okanogan** Telephone: (509) 826-7345 FAX: (509) 826-7349 TDD: (509) 826-7370 1234 2nd Avenue S PO Box 632 Okanogan, WA 98840-0632	**Vancouver** Telephone: (360) 896-2300 FAX: (360) 896-2345 TDD: (360) 896-2304 312 SE Stonemill Dr, Suite 120 Vancouver, WA 98684-6982
Colville Telephone: (509) 684-7417 Toll-free 1-800-509-9174 FAX (509) 684-7416 298 South Main, Suite 203 Colville, WA 99114-2416	**Port Angeles** Telephone: (360) 417-2700 FAX: (360) 417-2733 TDD: (360) 417-2752 1605 East Front Street, Suite C Port Angeles, WA 98362-4628	**Walla Walla** Telephone: (509) 527-4437 FAX: (509) 527-4486 TDD: (509) 527-4172 1815 Portland Avenue, Suite 2 Walla Walla, WA 99362-2246
East Wenatchee Telephone: (509) 886-6500 or 1-800-292-5920 FAX: (509) 886-6510 TDD: (509) 886-6512 519 Grant Road East Wenatchee, WA 98802-5459	**Pullman** Telephone: (509)334-5296 Toll-free 1-800-509-0025 FAX: (509) 334-3417 1250 Bishop Blvd SE, Suite G PO Box 847 Pullman, WA 99163-0847	**Yakima** Telephone: (509) 454-3700 Toll-free 1-800-354-5423 FAX: (509) 454-3710 TDD: (509) 454-3741 15 W. Yakima Avenue, Suite 100 Yakima, WA 98902-3480
Everett Telephone: (425) 290-1300 FAX: (425) 290-1399 TDD: (425) 290-1407 729 100th St. S.E. Everett WA 98208-3727	**Seattle** Telephone: (206) 281-5400 FAX: (206) 281-5529 TDD: (206) 281-5528 300 W Harrison Street Seattle, WA 98119-4081	
Kennewick Telephone: (509) 735-0100 FAX: (509) 735-0120 TDD: (509) 735-0146 500 N Morain, Suite 1110 Kennewick, WA 99336-2683	**Spokane** Telephone: (509) 324-2600 Toll-free: 1-800-509-8847 FAX: (509) 324-2636 TDD: (509) 324-2653 901 N Monroe Street, Suite 100 Spokane, WA 99201-2149	

Employers or employees who are not certain who or where to call, may contact L&I's Safety and Health Hotline at: **1-800-4BE-SAFE (1-800-423-7233)**

Additional Health Information

General Information on Toxics:

A variety of programs within state agencies and universities respond to questions regarding the toxic effects of exposures in the workplace, home or general environment. This includes reproductive effects of toxic substances, pesticides, hazardous wastes, infectious agents such as HIV, and physical agents such as radiation.

Washington State Department of Health
Office of Toxic Substances
7171 Clean Water Lane - Building 4
P.O. Box 47825
Olympia, WA 98504-7825
Telephone: (360) 236-3390

Washington State Department of Health
Office of Epidemiology
P.O. Box 47812
Olympia, WA 98504-7812
Telephone: (360) 236-4240

Washington State Department of Ecology
Hazardous Substance Information Office
P.O. Box 47659
Olympia, WA 98504-7659
Telephone: 1-800-633-7585

Pesticide Information Center On-Line
http://picol.cahe.wsu.edu

University of Washington
Department of Environmental Health
School of Public Health and Community Medicine
Box 357234
Seattle WA 98195
Telephone: (206) 543-6991

Eastern Washington University
Environmental Health & Safety Department, MS-160
Cheney, WA 99004
Telephone: (509) 359-6496

Pesticide Information Center
Washington State University Tri-Cities
100 Sprout Road
Richland, WA 99352
Telephone: (509) 372-7492

Poison Control Centers:

The Washington State Poison Control Center provides immediate information and referral regarding exposures at home or at work. Individuals who staff this center can provide information regarding exposure to drugs (prescription and non-prescription drugs), drug interactions and chemicals used at home or at the worksite. Telephone: 1-800-732-6985.

Birth Defects Information:

The Central Laboratory of Human Embryology can provide information about the effect drugs, chemicals and infectious agents may have on the fetus. The staff of physicians and other research professionals provide consultation using computerized databases.

University of Washington
Central Laboratory for Human Embryology
Department of Pediatrics, Box 356320
Seattle, WA 98195
Telephone: (206) 543-3373

To consult with Teratologists (professionals who specialize in agents that can cause birth defects) call:
Counseling and Advice on Reproductive Exposures
(CARE Northwest)
Telephone (toll call): 1-900-225-CARE

Genetics:

For questions about genetic issues, advanced maternal age, previous children with birth defects or chromosomal defects, and communicable disease exposures, you may contact the Department of Health office listed below.

Washington State Department of Health
Genetic Services Section
1511 Third Avenue
Suite 808
Seattle, WA 98101
Telephone: (206) 464-7718

Health Care Provider

Workers who are pregnant or think they are pregnant should be encouraged to see a health care provider. Consistent prenatal care is one of the most important factors in having a healthy child. In addition, the provider can help respond to concerns regarding workplace hazards to reproductive health.

In some cases, a health care provider may wish to contact an occupational medicine specialist. In particular, board-certified occupational medicine physicians are the best trained for evaluating exposure and reproductive risk for workers. The Yellow Pages lists local area physicians or you

may contact your county medical society for referrals. Also, the Harborview Medical Center, Occupational and Environmental Medicine Clinic is the Pacific Northwest training site for occupational medicine professionals and is available for consultation to other health care providers.

Harborview Medical Center
Occupational and Environmental Medicine Clinic
325 Ninth Avenue (Box 359739)
Seattle, WA 98104
Telephone: (206) 731-3005

Legal Questions

For questions regarding maternity leave regulations, concerns regarding discrimination during pregnancy, or legal rights when considering pregnancy, contact the local office of the Federal Equal Employment Opportunity Commission, or the Washington State Human Rights Commission.

The Washington State Human Rights Commission (Main Office)
711 S. Capitol Way, #402
P.O. Box 42490
Olympia, WA 98504-2490
TEL: 360-753-6770 -- FAX: 360-586-2282
Toll Free: 1-800-233-3247
TTY: 1-800-300-7525

Equal Employment Opportunity Commission
Federal Office Building
909 First Avenue, Suite 400
Seattle, WA 98104-1061
Telephone: (206) 220-6883
1-800-669-4000

For specific legal questions, you may need to contact a private attorney. The telephone book yellow pages list local area lawyers.

Other Resources for Workers

It is usually best for a worker to first bring concerns to his or her supervisor. For additional questions or concerns about the presence of workplace reproductive exposures, the employer's responsibilities regarding such exposures, or how questions can be addressed through labor/management interaction, you can contact the Washington State Labor Council. They may be contacted whether or not the worker is a member of a union.

Washington State Labor Council, AFL-CIO
906 Columbia St. SW #330
Olympia, WA 98501
Telephone: (360) 943-0608

Miscellaneous Resources

Organization of Teratology Information Services (OTIS)
Pregnancy/Environmental Hotline – State Referrals:
Telephone: (716) 874-4747 x 477

Association of Occupational and Environmental Clinics
Telephone: (202) 347-4976
http://gilligan.mc.duke.edu/oem/aoec.htm

American College of Occupational and Environmental Medicine (ACOEM)
55 West Seegers Road
Arlington Heights, Illinois, 60005
Telephone: 847/228-6850, FAX: 847/228-1856
http://www.acoem.org

American Industrial Hygiene Association
2700 Prosperity Avenue, Suite 250
Fairfax, VA 22031
Telephone: (703) 849-8888
FAX: (703) 207-3561
E-Mail: infonet@aiha.org
InfoFax Service: (703) 641-INFO
http://www.aiha.org

National Library of Medicine
Telephone: (800)-638-8480
http://www.nlm.nih.gov

Right-to-Know Network (RTKNet)
Telephone: (202) 234-8494
http://www.rtk.net

U.S. Department of Labor
Occupational Safety and Health Administration (OSHA)
Region 10
Regional Office
1111 Third Avenue, Suite 715
Seattle, Washington 98101-3212
Telephone: (206) 553-5930
(206) 553-6499 FAX
http://www.osha.gov/index.html

National Institute for Occupational Safety and Health (NIOSH)
Telephone: (800) 356-4674
http://www.cdc.gov/niosh/homepage.html

Vermont's Safety Information Resources on the Internet (SIRI)
http://hazard.com/

Center for Research on Occupational and Environmental Toxicology (CROET)
Oregon Health Sciences University (OHSU)
3181 SW Sam Jackson Park Road L606
Portland, Oregon 97201-3098
Telephone: 503-494-4273
FAX: 503-494-4278
Email: *croetweb@ohsu.ed*
http://www.ohsu.edu/croet/

National Institute of Environmental Health Sciences (NIEHS)
P.O. Box 12233
Research Triangle Park, NC 27709
Phone number: Office of Communications - 919/541-3345
http://www.niehs.nih.gov/

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333
Telephone: 1-800-447-1544
FAX: (404) 639-6359
Email: *ATSDRIC@cdc.gov*
To access ATSDR ToxFAQs: Hazardous Substance Fact Sheets:
http://atsdr1.atsdr.cdc.gov:8080/toxfaq.html

American Conference of Government Industrial Hygienists (ACGIH)
1330 Kemper Meadow Dr., Ste 600
Cincinnati, OH 45240
Phone: 513-742-2020
Fax: 513-742-3355
http://www.acgih.org/

Alberta Worker's Health Center
Telephone: 403-486-9009
http://www.web.net/~wrkrhlth/
Email: *wrkrhlth@web.net*

Washington State Pesticide Page
http://pep.wsu.edu/

Teratogen Exposure Registry and Surveillance (TERAS)
Department of Pathology
Brigham & Women's Hospital
75 Francis St.
Boston, MA 02115
Telephone: (617) 732-6507
FAX: (617) 732-7513

March of Dimes
Western Washington Chapter
1904 Third Avenue Suite 230
Seattle, WA 98101-1181
Telephone: 1-800-291-DIME
206-624-1373
FAX 206-292-8190
http://www.marchofdimes-wa.org

March of Dimes
Eastern Washington Chapter
Kennewick, WA
Telephone: 509-783-1099
FAX 509-783-7165

Safety & Health Assessment & Research for Prevention (SHARP)
Department of Labor & Industries
PO Box 44330
Olympia, WA 98504-4330
Telephone: 888-66-SHARP
FAX: 360-602-5672
http://www.wa.gov/lni/sharp

Databases

MICROMEDEX/REPRORISK®
Contact: Gail Heitland
6200 South Syracuse Way, Suite 300
Englewood, CO 80111-4740
Telephone: (303) 486-6400 and (800) 525-9083
FAX: (303) 486-6464

REPROTOX®
Contact: Kay Padgett
Reproductive Toxicology Center
Columbia Hospital for Women Medical Center
2440 M St. NW, Suite 217
Washington, DC 20037-1404
Telephone: (202) 293-5137

Teratogen Information System and the on-line version of Shepard's Catalog (TERIS)
Contact: Janine E. Polifka, Ph.D.
University of Washington
TERIS
Box 357920
Seattle, WA 98195-7920
Telephone: 206-543-2465

Written References

"Chemically Induced Birth Defects," J.L. Schardein, Marcel Dekker Inc., New York, 1993.
An exhaustive distillation of the human and animal teratological data for numerous chemicals.

"Reproductive Hazards in the Workplace: What the Practitioner Needs to Know about Chemical Exposures," M. Paul & J. Himmelstein, in: *Obstetrics and Gynecology* 71:921-938,1988.
This article for clinicians reviews the characterization of worksite exposures and determining an intervention strategy for patients. Clinical case examples are discussed. It also includes a review of workplace reproductive hazards resources, including computer databases.

"Occupational Medicine," C. Zenz, Mosby Year Book, Inc., 1988.
This classic textbook contains an informative chapter titled, "Reproduction Toxicology and Occupational Exposures," including a review of 23 important workplace exposures.

"Decisionmaking About Reproductive Hazards," L. Welch, in: *Seminars in Occupational Medicine* 1(2):97-106, 1986.
This article informs clinicians about the magnitude of reproductive health problems in the workplace, the information available on which to base answers to questions and presents an approach to diagnosis and management.

"Occupational Hazards and Reproduction," K. Hemminki, M. Sorsa, and H. Vaino, Hemisphere, New York, 1985.
This book includes much of the research relating to workplace reproductive hazards and reproductive biology that was presented at the International Course on Occupational Hazards and Reproduction held in Helsinki, Finland in 1981.

"Reproductive and Developmental Hazards: An Overview for Occupational and Environmental Health Nurses," Agency for Toxic Substances and Disease Registry, in: *American Association of Occupational Health Nurses Journal* 46(2): 57-65, 1998.

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"Workplace Chemical Hazards to Reproductive Health: A resource for worker health and safety training and patient education," P. Coyle, C.S. Forest, and J. Norling, Hazard Evaluation System and Information Service (HESIS), Berkeley, CA, 1990.

"Biologic Agents and Pregnancy," U. Ekblad, in: *Journal of Occupational and Environmental Medicine, 37(8): 962-965, 1995.*

"Pregnant Workers: A physician's guide to assessing safe employment," J.S. Feinberg and C.R. Kelley, in: *Western Journal of Medicine* 168(2): 86-92, 1998.

"Reproduction and the Workplace: What We Know and Where We Go from Here," I. Figa-Talamanca and M.C. Hatch, in: *International Journal of Occupational Medicine and Toxicology* 3(3): 279-303, 1994.

"Introduction: Rational for an update," E.B. Gold, B.L. Lasley, and M. B. Schenker, in: E.B. Gold, B.L. Lasley, and M. B. Schenker, Eds., *Reproductive Hazards, Occupational Medicine: State of the Art Reviews* 9(3) 363-372, 1994.

"Handbook of Pesticide Toxicology," W.J. Hayes, Jr. and E.R. Laws, Jr, Editors, Academic Press, Inc, San Diego, 1991.

"Viral Infections," B. Jantausch and J.L. Sever, in: M. Paul, Ed., *Occupational and Environmental Reproductive Hazards: A guide for clinicians,* Williams and Wilkins, Baltimore, pp.319-333, 1993.

"Epidemiology of Reproductive Hazards in the Workplace," G.K. Lemasters, in *Occupational Medicine: State of the Art Reviews* 11(3): 545-560, 1996.

"Ergonomics," M. Marbury, in M. Paul, Ed., *Occupational and Environmental Reproductive Hazards: A guide for clinicians,* Williams and Wilkins, Baltimore, pp.201-217, 1993.

"Occupational Exposures to Pharmaceuticals: Antineoplastics, Anesthetic Agents, Sex Steroid Hormones," M. McDiarmid, in: M. Paul, Ed., *Occupational and Environmental Reproductive Hazards: A guide for clinicians,* Williams and Wilkins, Baltimore, pp.280-295, 1993.

"The Developing Human: Clinically oriented embryology," Sixth edition, K.L. Moore, Saunders, Philadelphia, 1998.

"The Effects of Workplace Hazards on Male Reproductive Health," National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department Of Health & Human Services, DHHS (NIOSH) Publication No. 96-132, 1996.

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"Clinical Evaluation and Management," M. Paul, in: M. Paul, Ed., *Occupational and Environmental Reproductive Hazards: A guide for clinicians,* Williams and Wilkins, Baltimore, pp.113-136, 1993.

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Glossary

birth defect · A structural, functional, or biochemical abnormality present at birth that is not due to injuries suffered during birth. The cause may be either genetic or due to a problem that occurred during development in the uterus. A birth defect is not always 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."

clastogen · A chemical or physical agent that can cause breaks in chromosomes (genetic material in the cell).

congenital malformation · A physical abnormality present at birth (birth defect).

developmental toxicant · An agent which disturbs the proper growth or health of the offspring, acting at any point between conception and puberty. The resulting effects include spontaneous abortion, growth retardation, birth defects, and functional alterations.

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.

endocrine · Organs and structures whose function is to secrete into the blood or lymph a substance (hormone) that has a specific effect on another organ or part.

engineering controls · Methods of controlling worker exposure by modifying the source or reducing the amount of contaminants released into the workplace. Engineering controls include process design and modification, equipment design, enclosure and isolation, and ventilation.

epidemiology · The study of the patterns of health and disease in a population of people.

exposure · An encounter between a chemical, biological, or physical agent and a worker. Usually expresses in terms of amount in air, water, dusts.

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

fetus · The developing human from about 8-9 weeks until birth.

gene · The part of the genetic material of a cell that encodes a particular protein.

hormone · A chemical substance, produced in the body or by an organ or cells of an organ which is secreted into the bloodstream and has a specific regulatory effect on the activity of a certain organ or organs.

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

ingestion · Taking in a substance through the mouth and swallowing it, including substances first inhaled, adsorbed, and then ingested.

inhalation · Breathing in a substance.

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

material safety data sheet (MSDS) · A legally-mandated form which lists the hazardous ingredients, physical and chemical properties and health and safety hazards of a product or substance.

menstruation · Shedding the lining of the uterus.

mutagen · A chemical or physical agent which can change the DNA (genetic material) in cells.

ovulation · Release of an egg from the ovary.

permissible exposure limit (**PEL)** · A maximum allowable exposure level under OSHA and WISHA regulations. Weighted over an 8-hour work shift.

personal protective equipment · Equipment and clothing designed to control exposure to hazards, e.g., hard hats, safety shoes, protective eye wear, protective clothing and gloves, hearing protectors and various types of respirators, such as dust and gas masks.

Regulatory Code of Washington RCW · The laws of Washington State.

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

reproductive toxicant · An agent which interferes with the sexual or reproductive function or performance of an adult.

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 · Death of the embryo or fetus before full term (usually defined as before 20 weeks). Also known as miscarriage.

still birth · Death of the embryo or fetus before full term (usually defined as after 20 weeks).

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

toxicant · An agent that interrupts the normal function of a cell, tissue, organ or organism.

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

Washington Administrative Code WAC · The rules and regulations adopted to carry out the laws of the state of Washington.

Feedback

We value your opinion, and would like to learn what you thought about this booklet. Please take just a few minutes to answer the questions below and then return the completed page to SHARP. Thank you!

1. Which phrase BEST describes your work position?

- ☐ Hourly employee
- ☐ Salaried employee
- ☐ Management
- ☐ Health & safety professional
- ☐ Health care provider
- ☐ Other (please describe)

2. On a scale of 1 to 5, please rate the following aspects of this booklet by circling the number that best represents your opinion.

	Poor	*Fair*	*Good*	*Very good*	*Excellent*
Readability	1	2	3	4	5
Organization	1	2	3	4	5
Usefulness	1	2	3	4	5
Graphics	1	2	3	4	5
Overall quality	1	2	3	4	5

3. Have you used the recommendations provided in this booklet in your workplace or as part of a workplace evaluation? ____Yes ____No

4. As a result of using the information in this booklet, have exposures to potentially hazardous substances been reduced or eliminated? ____Yes ____No

Please feel free to provide us with any additional comments in the space below. If you wish, provide contact information so that we can follow-up on your comments.

_____
_____
_____
_____

THANK YOU

Please return this page to:

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Appendix A

CLASSIFICATION OF WORKPLACE HAZARDS

The REPROTEXT® System was used to classify the effects of workplace agents. This computerized database describes effects on human reproduction and development of acute and chronic exposures to numerous substances (including industrial chemicals commonly encountered in the workplace) as well as carcinogenic and genetic influences. This system includes a "grade-card" scale of weight-of-evidence for reproductive/developmental hazard (see below).

The following series of tables summarize the major reproductive and developmental hazards in common usage, presented by the type of workplace in which they are used. Since some workplace agents were not present in the REPROTEXT® database, the authors of this booklet classified these hazards based on available data. The author's classifications are denoted by shading and assigning an asterisk (*).

A+	Human reproductive hazard with no known no-effect dose.
A	Human reproductive hazard with known no-effect dose.
A–	Unconfirmed human reproductive hazard.
B+	Multiple reproductive effects in animals, no human data.
B	Mixed reproductive effects in animals but no human data.
B–	Few reproductive effects in animals but no human data.
C	No reproductive data found.
E	Known not to affect animal reproduction but no human data.
F	Known not to affect human reproduction.

The REPROTEXT® data are reprinted with permission from MICROMEDEX, Inc.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Acetaldehyde 75-07-0	Organic solvent. Intermediate in the synthesis of acetic acid, pentaerythritol, and pyridine. Used in the production of perfumes, polyester, resins, dyes, explosives, varnishes, lacquers, and plastics. Used in mirror silvering, photographic chemicals, food preservatives, vinegar, gelatin fibers, glue and casein products, leather tanning, rubber, chemical, and paper industries.	A–	Connection between fetal alcohol syndrome and acetaldehyde as an ethanol metabolite. Acetaldehyde is not thought to be a reproductive risk when the mother is not affected and under normal workplace exposures.
Acetone 67-64-1	Organic solvent. Chemical intermediate. Used in metal cleaning and acetate fiber delustering.	A–	Unconfirmed human reports of : -delayed menstrual cycles -mixed exposures of acetone and other chemicals resulting in increased risk of birth defects - increased risk of birth defects in children of diabetics.
Acrolein 107-02-8	Chemical intermediate, pesticide, poison gas, liquid fuel, and aquatic pesticide. Used in plastics manufacturing.	B–	Embryotoxicity and possible teratogenicity in experimental animals.
Acrylamide 79-06-1	Intermediate in the production of organic chemicals. Reactive monomer. Used in adhesives, paper sizing, fibers, molded parts, textiles, water coagulant aids, sewage and waste treatment, and ore processing.	B+	No human studies. Affects male and female fertility in experimental animals. Fetotoxic but not teratogenic in experimental animals.
Acrylonitrile 107-13-1	Chemical intermediate, pesticide fumigant (Fumigrain, Ventox). Found in plastics, acrylic fibers, adhesives, synthetic rubber, and plastic surface coatings.	A–	Reductions in serum testosterone in exposed workers. Experimental animal teratogen. Degeneration of seminiferous tubules and sperm in mice.
Aldrin 309-00-2	Organochlorine pesticide no longer manufactured in the United States; however some is imported for termite control.	B+	Fetotoxic and teratogenic in experimental animals. Affects fertility in multiple experimental animal species.
Aluminum 7429-90-5	Welding of aluminum metal and alloys. Chemical intermediate. Structural metal. Found in alloys, packaging, cookware, paint pigments, pyrotechnics, and food additives.	A–	Elevated aluminum levels in drinking water associated with birth defects in humans.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Ammonia 7664-41-7	Refrigerant, fertilizer, cleaning/bleaching agent, latex preservative, condensation catalyst for polymers, dyeing or neutralizing agent in the petroleum industry. Used in rocket fuels, explosives, and synthetic fibers. Used in the manufacture of nitric acid, hydrazine hydrate, hydrogen cyanide, nitrocellulose, urea formaldehyde, nitroparaffins, melamine ethylene diamine, sulfite cooking liquors, and acrylonitrile. Chemical manufacturing, developing of diazo films, nitriding of steel.	A–	Russian reports of effects on human reproduction. Women in the last trimester of pregnancy and at risk for toxemia should have their workplace exposures evaluated.
Aniline 65-53-3	Simple aromatic amine. Solvent and chemical intermediate. Used in the manufacture of dyes, rubber accelerators, antioxidants, ion exchange resins, plastics, photographic developers, and pharmaceuticals.	A+	May induce methemoglobinemia in the fetus.
Antimony 7440-36-0	Crystalline, silver-white metal. Used in metal alloys, textiles, and bullets. Fireproofing agent. Potential exposures to battery workers, solderers, welders, semiconductor workers, textile workers, metal workers, bullet manufacturers.	A–	Report of miscarriages, stillbirths, and developmental effects in humans. Found in human milk
Antimony Potassium Tartrate 28300-74-5	Medical uses as antischistosomal agent (use suspended), expectorant, emetic, and antiprotozoal agent. Used as a textile mordant, and ant, moth, wasp, and snail bait.	A–	One report of female metallurgists working with antimony aerosols reporting increased incidence of premature births, miscarriages, and gynecological disorders. Relevance to chronic antimony potassium tartrate exposure unclear but effects are consistent with reports in experimental animals. Not thought to be teratogenic in therapeutic use.
Arsenic 7440-38-2	Used in alloys, solders, silicon, electronics and semiconductors, chemical manufacturing, glass, pottery, insecticides, rodenticides, herbicides, wood preservatives, veterinary medicine, metal smelting, welding, tanning, and fertilizer manufacturing (from phosphate rock).	A–	Reports of miscarriages and birth defects in women exposed to arsenic.
Atrazine 1912-24-9	Triazine herbicide. Used on crops such as maize, sorghum, sugarcane, pineapples, and nursery conifers. Also used for general weed control and selective control of pond weeds.	A–*	Increases in birth defects and male sex ratios seen in offspring of pesticide appliers. No adverse reproductive or developmental effects in experimental animals.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Benomyl 17804-35-2	Widely used in agriculture and home gardening as a fungicide and ascaricide. Used as a worming agent in veterinary medicine.	A–	Clusters of eye and central nervous system defects in humans have not been confirmed by larger studies. Teratogen in mice and rats, especially in undernourished animals. Male reproductive hazard in experimental animals.
Benzene 71-43-2	Solvent, chemical reagent, fuel, chemical feedstock, gasoline additive. Used in the petroleum and rubber industries, chemical manufacturing, electronics, semiconductors, general manufacturing, automobile production and repair, and paints.	A–	Heavy menstrual bleeding and bleeding disorders of pregnancy in humans.
Bisphenol A, Diglycidyl Ether (DGEBA) 80-05-7	Component of epoxy resins. Fungicide.	C	No human studies. Limited experimental animal data suggest impaired reproductive capacity, hydrocephaly, growth retardation, impaired bone formation, and fetal toxicity.
Boric Acid 10043-35-3	Used in weatherproofing wood, fireproofing fabrics, printing, paint, and electronics. Used in the manufacture of cements, glass, enamels, and hardening steel. Used as an astringent, antiseptic, and in cosmetic powders. Insecticide for cockroaches and black carpet beetles.	A–	Effects on the testes, sperm production, and fertility in rats and dogs. Human reports suggest similar effects in men.
Boron oxide 1303-86-2	Crystalline solid that easily absorbs water. Used in herbicides, fire retardants for paints, and welding flux. Used in the manufacture of glass, enamels, and glazes.	A–	No reproductive studies found for humans or animals but listed as A– because it is a borate.
Bromine 7726-95-6	Used in the manufacture of fuel additives, fire extinguishing agents, fire-retardants for plastics, photographic chemicals, and dyes. Also used in gold extraction, bleaching, pharmaceuticals, dyestuffs, organic synthesis, water purification, shrink-proofing wool, and as an intermediate for fumigants.	A–	Human cases suggesting: -suppression of spermatogenesis -impaired sexual and reproductive performance Use of bromides should be discouraged in breast-feeding women.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Busulfan 55-98-1	Alkyl sulfonate. Orally administered cancer chemotherapeutic drug. Potential for exposure in health-care settings.	A+	Reports of human female reproductive toxicity. No dose level identified that does not cause adverse reproductive effects. Limited human studies have also shown spontaneous abortion, birth defects, and growth retardation. Experimental animal studies have shown male reproductive toxicity, teratogenicity, embryotoxicity, and fetotoxicity. It is not known whether workplace exposure of pregnant women to busulfan is problematic.
Cadmium 7440-43-9	Widespread environmental element. Used in electroplating other metals, pigments, stabilizers for plastics, alloys, wires, electrodes, dental amalgams, phosphorus in cathode ray tubes, photography, lasers, solar cells, scintillation counters, nickel-cadmium batteries, ceramic glazes, fire protection systems, baking enamels, pesticides, nuclear reactor control rods, soft solder, and cadmium-vapor lamps.	A–	Chronic exposure affects the testes and fertility in men. Reproductive effects in several species of experimental animals.
Carbamide (Urea) 57-13-6	Noncombustible crystalline solid. Used in commercial fertilizers, animal feed supplements, plastics, explosives, cosmetics, flame-proofing agents, some diuretic drugs, urea-formaldehyde foam insulation, and urea-formaldehyde resins.	A–	No evidence of birth defects in experimental animals but has caused abortion in humans when administered into amniotic fluid. Actual human reproductive hazard unknown.
Carbaryl 63-25-2	Carbamate cholinesterase inhibitor. One of the most widely used pesticides. Active ingredient in the broad-spectrum contact insecticide SEVIN. Used to control insects on field crops, forage, vegetables, fruit, nuts, shade trees, ornamental, forests, lawns, turf, rangeland. Also used to control insects on domestic animals.	A–	May affect human sperm. Reported to affect male and female fertility, as well as the unborn, in many experimental animal studies. Adverse effects in several wildlife species.
Carbon Dioxide 124-38-9	Colorless, odorless, gas. Used in carbonation of beverages, fire extinguishers, aerosol propellants, dry ice, shield-arc welding, and as a laser source. May be present in mines, submarines, tanks, vats, and confined and unventilated spaces.	B+	No human studies. Malformations in the offspring of experimental animals. Male reproductive effects in experimental animals.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Carbon Disulfide 75-15-0	Inorganic compound. Used as a corrosion inhibitor, catalyst, solvent and chemical intermediate for cellophane and rubber products, fumigant and soil treatment against insects and nematodes, metal remover in waste water treatment. Widely used in the textile industry. Used in the manufacture of carbon tetrachloride, xanthogenates, paints, varnishes, paint removers, optical glass, explosives, rocket fuel, rubber cement, glues, resins, electronics, tallow, and fresh fruit preservatives. Worming agent in veterinary medicine.	A+	Reproductive effects in humans: -spontaneous abortions -premature births -birth defects -decreased sperm production -loss of libido -menstrual irregularities Embryotoxicity, fetotoxicity, and malformations in experimental animals.
Carbon Monoxide 630-08-0	Colorless, odorless, gas. Common air pollutant. Component of cigarette smoke. Used in the Mond process for nickel recovery. Metallurgical operations, organic synthesis, and production of metal carbonyls. Present in parking and repair garages, and toll booth areas. Industries associated with pulp and paper manufacturing, blast furnace operations, breweries, carbon black, coke oven, and petroleum.	A+	Humans: -Possible neurological effects in offspring. -Female reproductive toxicity. -Spontaneous abortion -Growth retardation -May be no margin of safety for exposure. Workplace exposure in combination with maternal smoking may increase risk for neurological impairment in offspring.
Carbon Tetrachloride 56-23-5	Chlorinated hydrocarbon. Organic solvent. Persistent common environmental pollutant. Highly toxic. Mainly used as chemical intermediate. Used in chemical manufacturing, dry cleaning, pharmaceuticals, electronics, general manufacturing, automobile manufacture and repair, and paper manufacture. Used to a lesser degree as a degreaser, fire extinguisher, grain fumigant, and worming agent in veterinary medicine.	B+	No human studies. Experimental animals: Embryotoxic and fetotoxic at doses that were also toxic to the mother. Male and female reproductive effects in rats.
Chlorambucil 305-03-3	Alkylating agent used in cancer chemotherapy. Concern about exposures to medical personnel and pharmaceutical manufacturers of childbearing age.	A+	Known human reproductive hazard. Clinical use associated with infertility in males and females and birth defects of the urogenital system. Renal defects and malformations of the central nervous system, limbs, and cranium seen in experimental animals.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Chloroform 67-66-3	Widely used industrial and laboratory solvent, cleaning agent, and chemical intermediate. Used in the rubber industry, handling of wastewater sludge. Formerly used as an anesthetic. Banned in the USA from use in human drugs and cosmetics.	A–	Report of eclampsia in two women who worked with chloroform. Embryotoxic, fetotoxic, and teratogenic in experimental animals.
Chlorpyrifos (Dursban) 2921-88-2	Organophosphorus insecticide. Acetylcholinesterase inhibitor. Widely used to control adult mosquitoes, flies, many foliage crop pests, household pests, and aquatic larvae.	A–	Isolated reports of human birth defects. Similar defects were seen in experimental animals. Other studies in rats produced no birth defects or fertility problems over three generations.
Chromium 7440-47-3	Steel-gray, hard, lustrous metal. Many chromium alloys and inorganic chromium compounds are used in industry. Used in stainless steel, alloy steels, refractory products, leather tanning agents, textiles, pigments, electroplating, catalysts, corrosion resistant products, anticorrosive paints, photographic processing, welding fumes.	B+	No human studies. Birth defects and fertility problems in experimental animals.
Copper 7440-50-8	Flexible reddish metal. Excellent conductor of heat and electricity. Used in electrical equipment, alloys, cooking utensils, catalysts, heating, piping, and pigments. Copper salts used in insecticides, fungicides, algaecides, pigments for paints and inks, and medicines. Mixed exposures with other metals are encountered in mining, smelting, foundries, and welding.	A–	Possible connection between exposure to copper and other metals, and miscarriages among women working in the metallurgy industry. Mixed results in experimental animal birth defect studies.
Cyclophosphamide (Cytoxan; Neosar) 50-18-0 (anhydrous) 6055-19-2 (hydrated)	Alkylating agent used in cancer chemotherapy and as an immunosuppressant. Concern about exposures to medical personnel and pharmaceutical manufacturers of childbearing age.	A*	Therapeutic exposures associated with congenital malformations in humans. Produced birth defects in all experimental animals tested.
Cytomegalovirus	Common cause of an infectious mononucleosis-like syndrome. Acquired via contact with saliva, urine, stool, respiratory tract secretions, blood, and breast milk. Potential for exposure in health- and child-care settings and schools.	A*	Spontaneous abortion, microcephaly, mental retardation, hearing loss, eye abnormalities, and neurological dysfunction in humans. Present in human milk. Transmission usually prevented by good personal hygiene and appropriate personal protective equipment.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Diazinon 333-41-5	Commonly used organophosphorus insecticide and acaricide (destructive to mites). Household and agricultural use. Cholinesterase inhibitor. Used for cockroach control and insects resistant to chlorinated hydrocarbons.	A–	Unconfirmed report of impotence in exposed male humans. Neurobehavioral and structural defects in experimental animals.
Dibromochloropropane (DBCP) 96-12-8	Brominated organochlorine. Nematodocidal soil fumigant	A*	High workplace exposure associated with infertility in men. Reduced male/female sex ratio in the children of heavily exposed men. Testicular toxicant in experimental animals.
Dichlorodiphenyltrichloroethane (DDT) 50-29-3	Organochlorine (chlorinated hydrocarbon) insecticide. No longer used in the USA except under emergency conditions. Still used in other parts of the world.	A–	Estrogenic effects. Humans: -Associated with an increased frequency of spontaneous abortion, stillbirths, and complications of pregnancy and childbirth -Excreted in breast milk. -Crosses the placenta. Experimental animals: -Inconsistent reports of fetotoxicity and embryotoxicity.
2,4-Dichlorophenoxy-acetic Acid (2,4-D) 94-75-7	Herbicide used on broadleaf weeds such as lambs-quarters, pigweed, smartweed, and ragweed. Often used in combination with other herbicides such as linuron.	A–	Unconfirmed reports of human birth defects, miscarriages, and male and female reproductive problems in occupationally exposed individuals. Reports of embryotoxic, fetotoxic, and teratogenic effects in animals.
Dichlorvos 62-73-7	Organophosphorus insecticide and used on some internal parasites. Cholinesterase inhibitor. Used for control of insects in tobacco warehouses, mushroom houses, greenhouses, animal shelters, homes, restaurants, and other food handling establishments.	B	No human studies. Teratogenic in swine. Adverse paternal reproductive effects, and postimplantation mortality in experimental animals.
Dicofol 115-32-2	Mitacide on citrus fruits, nuts, cotton, and beans. Worming agent in veterinary medicine.	B–*	No human studies. Single report of malformations in mice.
Dieldrin 60-57-1	Organochlorine insecticide used mainly to control vectors of disease. Estrogenic oxidation product of aldrin and isomer of endrin.	B*	Reproductive and developmental effects in experimental animals.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Di(2-ethylhexyl) phthalate (DEHP) 117-81-7	Plasticizer in plastics and rubber materials such as polyvinyl chloride resins, vinyl chloride copolymer resins, cellulose ester resins and polystyrene resins. Component of dielectric fluids in electrical capacitors and vacuum pump oil. Inert ingredient in pesticides, solvent for erasable ink, acaracide in orchards, dye carrier, and testing agent for air filtration systems.	B+*	No human studies. Well-documented testicular toxicant in several animal species. Teratogenic effects, fetotoxicity, and developmental anomalies have been reported in experimental animals.
Diethylstilbestrol (DES) 56-53-1	Synthetic non-steroidal estrogen. Medication. Pharmaceutical industry.	A+	Known transplacental female reproductive tract carcinogen. Adverse effects in males, females, and the unborn. Workplace studies are lacking but workplace exposure during pregnancy is discouraged.
Dimethoate 60-51-5	Organophosphorus insecticide marketed as Cygon and Rogor. Contact and systemic insecticide and acaricide. Used on a wide range of crops. Cholinesterase inhibitor.	A–	One report of spontaneous delivery after dimethoate poisoning. Fetotoxic, teratogenic, and toxic to the testes in experimental animals.
Dimethylformamide (DMF) 68-12-2 (Synonyms: N,N-Dimethylformamide)	Industrial solvent. Catalyst in carboxylation reactions and organic synthesis. Carrier for gases. Metabolized to N-Methylformamide: a potent animal teratogen. NIOSH is currently promoting reduction of use. Variety of industrial uses including tanning leather and aircraft repair.	A–	Associated with miscarriages, fetal death, and female reproductive problems in humans. Embryotoxic, fetotoxic, and teratogenic in several species of experimental animals.
Dimethyl Phthlate 131-11-3	Solvent, plasticizer. Mosquito and insect repellent in World War II. Used in varnishes, perfumes, safety glass, and chemical lights.	B	No human studies. Embryotoxic and teratogenic in rats, but not mice.
Dimethyl Sulfoxide (DMSO) 67-68-5	Widely used organic solvent. Bladder irrigant for treatment of cystitis. Topical therapy for scleroderma. Cryoprotectant in freezing animal and human embryos.	B*	No human studies. Mixed reports of developmental effects in experimental animals.
Dinitrotoluene (DNT) 25321-14-6	Used in the production of toluene diisocyanate and toluenediamine. Used in polyurethane foams, polymers, plastics, explosives, and dyes.	A+	Induces methemoglobinemia in the fetus. Unconfirmed report of increased abortion in wives of workers exposed to DNT. Male reproductive effects in experimental animals.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Dinoseb 88-85-7	O-dinitrocresol compound. Herbicide, plant growth regulator, insecticide, ovicide, and desiccant.	B+	No human studies. Embryotoxic, fetotoxic, and teratogenic in experimental animals. Male reproductive effects in experimental animals. Can induce methemoglobinemia in experimental animals but not known to do so in humans.
Dioctyl Phthalate See Di (2-ethylhexyl) Phthalate (DEHP)			
Endosulfan 115-29-7	Chlorinated hydrocarbon (organochlorine) pesticide used as an insecticide and acaricide on a wide variety of agricultural pests. Chemically related to Aldrin and Dieldrin.	B+	No human studies. Effects on the reproductive systems of experimental animals.
Epichlorohydrin 106-89-8	Used in the manufacture of chemicals, plastics, resins, glycerin, lubricants, adhesives, lacquers, paints, pesticides, textiles, automobiles, and semiconductors.	B*	No human studies. Male reproductive toxicity seen in experimental animals. Epichlorohydrin is a metabolite of dibromochloropropane.
Ethyl Alcohol 64-17-5	Industrial uses as a solvent, fuel or fuel additive, and chemical intermediate.	A+	Studied extensively because of its widespread recreational use. Workplace exposure is primarily through inhalation. Effects on male fertility. Produces fetal alcohol syndrome. Ethanol produces the same fetotoxic effects in experimental animals whether it is inhaled or ingested.
Ethylene Dibromide (EDB) 106-93-4	Lead scavenger in leaded gasoline. (Use reduced in US due to the transition to unleaded gasoline.) Pesticide and fumigant. (Banned in US). Used in fire extinguishers and gauge fluids. Chemical intermediate and solvent. Used in wood processing, pharmaceuticals, textiles, resins, gums, and waxes.	A–	Evidence that EDB may affect fertility in human males. Fetotoxic in experimental animals. Male and female reproductive toxicant in experimental animals.
Ethylene Glycol Monoethyl Ether (EGEE) 110-80-5	Glycol ether. Solvent. Used in the production of inks, varnishes, varnish removers, adhesives, paints, cleaners, dye baths, brake fluids, pesticides, perfumes, cosmetics, circuit boards, electronics and photographs. Anti-icing additive in aviation fuels.	A–	One report of menstrual disturbance and birth defects in women exposed to EGEE plus other chemicals. Reduced fertility in male experimental animals. Teratogenic in experimental animals.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Ethylene Glycol Monomethyl Ether (EGME) 109-86-4	Glycol ether. Solvent. Anti-icing additive in aviation fuels. Fungicide. Used in the production of inks, varnishes, varnish removers, adhesives, paints, cleaners, dye baths, brake fluids, pesticides, perfumes, cosmetics, circuit boards, electronics and photographs. Anti-icing additive in aviation fuels.	A–	May be the most toxic glycol ether. One human study in which males were found to have slightly reduced testicular size. EGME has produced central nervous system, cardiovascular, and skeletal birth defects, damage to the testes, reduced sperm number, infertility, and abnormal sperm in experimental animals.
Ethylene Oxide 75-21-8	Chemical intermediate in the manufacture of glycols. Ripening agent for fruits and tobacco leaves. Fungistat, insecticidal fumigant, agricultural fungicide. Rocket propellant. Sterilizing agent for surgical instruments, medical apparatus, and heat sensitive products. In chemicals, plastics, and clothing and textiles.	A–	Reports of increased spontaneous abortions in female health care personnel. Female and male reproductive toxicity and fetotoxicity in experimental animals.
Ethylene Thiourea 96-45-7	Neoprene rubber manufacture, pesticide use.	B*	No human studies. Mixed results in experimental animals, but teratogenic in rats.
Fluoroacetic Acid 144-49-0	Strong Acid. Metabolite of fluoro ester compounds. Rodenticide.	B–	No human or animal reproductive studies. Listed because of similarity to sodium fluoroacetate (an animal reproductive toxicant).
Formaldehyde 50-00-0	Colorless gas. Used in the production of paint, clothing, paper, plastics, fumigants, disinfectants, germicides, fungicides, insecticides, herbicides, fertilizers, synthetic fabrics, plywood, dyes, explosives, rubber preservers and coatings. Component of polyacetal, melamine, phenolic, and urea resins. Used in chemical analysis and synthesis, preservation of biological specimens, embalming, in drilling muds, photograph development, auto manufacturing, and construction.	A–	Affects the menstrual cycle of human females and may increase risk of spontaneous abortion.
Gasoline 8006-61-9	Clear, flammable, volatile liquid. Can contain as many as 250 different hydrocarbons. Usually used as a motor fuel. Sometimes used as a cleaning solvent.	A–	Reports of menstrual disturbances and isolated birth defects in humans (many of these reports involved poorly documented or mixed exposures).
Halothane 151-67-7	Halogenated hydrocarbon used as an anesthetic.	B+*	No human studies. Developmental delay, skeletal variants, and long-lasting behavioral abnormalities observed in the offspring of rodents treated with doses consistent with workplace exposure.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Heat, Excessive	Exposures include working outdoors in hot climates, working indoors without proper ventilation, wearing protective clothing, hot industrial processes.	A–	Workplace exposure may be associated with reproductive problems, but a dose-response estimation has not yet been determined.
Heavy Physical Exertion (e.g. repetitive heavy lifting, stooping and/or climbing)	Many workplaces.	A*	Premature delivery and low birth weight in humans.
Hepatitis B Virus	Virus acquired by percutaneous inoculation such as needlestick injuries. Potential for exposure in health-care settings.	A*	Virus transmitted to infant in utero, during delivery, or through breast milk. Infected children at increased risk for liver disease.
High Frequency Electromagnetic Radiation	Health care, thermal plastic sealing, glue hardening, radar technology, and telecommunications.	A–*	Human data are controversial. NIOSH lists military radar as a male reproductive hazard - decreased number of sperm
Human Immunodeficiency Virus (HIV)	Virus acquired by percutaneous inoculation such as needlestick injuries. Potential for exposure in health-care settings, rescue workers, funeral/mortuary workers.	A*	HIV may be transferred to the fetus via the placenta or during delivery. Cesarean section may decrease the risk of transmission. Growth failure, abnormal facial features, microcephaly, and prematurity reported in some exposed fetuses.
Ionizing Radiation	Nuclear medicine, nursing, uranium mining, phosphate industry, laboratories, atomic power industry, food processing, and dentistry.	A	Effects on male and female reproduction. Increased risk of cancer and mental retardation in offspring. Effects on the central nervous system. Spontaneous abortion. Similar effects have been seen in experimental animals.
Lead 7439-92-1	Soft, malleable, blue-gray metal. Used in storage batteries, paint pigments, industrial paint, dyes, and wood preservatives. Exposures occur in smelting, battery production, printing, painting, construction, soldering, stained glass window making, soldering, battery recycling, mining, welding, glass and pottery making, radiator repair, plumbing, electronics, and firing ranges.	A+	Effects on male and female reproduction. Spontaneous abortion and low birth weight seen with maternal or paternal exposure. Significant neurodevelopmental effects in offspring. Lead crosses the placenta and is present in breast milk.
Lindane 58-89-9	Organochlorine pesticide. No longer produced in the US but it may be used and formulated. Insecticide, topical treatment of scabies and lice.	A–	Isolated reports of increased bleeding in childbirth, stillbirths, alteration of menstrual cycles, and male infertility. Crosses the placenta and is concentrated in breast milk

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Lithium 7439-93-2	Used in vacuum tubes, catalysts, rocket propellants, fuels, organic synthesis, metallurgy, anodes in batteries, solder and brazing alloys, reducing agents, pharmaceuticals, aluminum and magnesium alloys, coolant or heat exchangers, lubricants, and in photography.	A–	Little or no data on lithium at workplace exposure levels. However, studies of patients taking lithium carbonate therapeutically for manic-depressive illness are associated with birth defects, especially in the heart and great vessels, with maternal use. Effects on the sperm of men taking lithium.
Malathion 121-75-5	Organophosphate pesticide. Inhibitor of acetylcholinesterase. Least toxic of the organophosphate family. Insecticide, acaracide, pediculicide. Used to control mosquitoes, flies, household insects, animal ectoparasites, and human head and body lice.	B+	No human studies. Effects on development and reproduction in several species of experimental animals.
Manganese 7439-96-5	Gray-white metal resembling iron. Necessary in trace amounts in the diet and in normal prenatal development. Used commercially in ferrous and nonferrous alloys, manganese dioxide in dry cell batteries, oxidizer to produce permanganate, a coating for welding rods, in the manufacture of ceramics, matches, glass and pottery, pharmaceuticals, steel, paints, fungicides, fireworks, and dyes. Used in methylcyclopentadienyl manganese tricarbonyl, an antiknock additive in fuels. Used as tissue-specific contrast agents for magnetic resonance imaging.	A–	Reports of impotence in miners with severe manganese poisoning. Excess manganese salts affect male fertility in several animal species. Manganese DEFICIENCY elicits birth defects in several species of experimental animals.
Mercury (metallic mercury and its inorganic salts) 7439-97-6	Heavy metal, liquid at room temperature, can occur as vapors, dusts, and aerosols. Used in thermometers, manometers, silent electrical switches, fluorescent lamps, polyurethane foams, mildew-proof paints, fungicides, amalgams, mirrors, and catalysts. Used in the metal, chemical, and pharmaceutical industries, dentistry, manufacture and use of pesticides.	A–	Numerous reports of male and female reproductive toxicity and developmental toxicity in humans.
Mercury (Organic mercury, methyl-mercury)	Organic mercury compounds are used as fungicides in paints, waxes, pastes, fabrics, cork, rubber, wood and in agriculture. Used as antiseptics, germicides, diuretics, and contraceptives in medicine. Used as catalysts in the chemical industry.	A+	Human teratogen. Found in human milk. Crosses the placenta
Methane 74-82-8	Principle component of natural gas. Used as a fuel and chemical intermediate.	B–	No human studies. Central nervous system defects in mouse embryos.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Methanol (Methyl Alcohol) 67-56-1	Colorless, volatile, flammable, liquid. Used as an industrial solvent, antifreeze, denaturant for ethanol, chemical intermediate, fuel or fuel additive, embalming fluid. Used in paints, paint and varnish removers.	A–	Mixed or poorly documented exposures in humans studies. Developmental toxicant in animal studies.
Methotrexate 59-05-2	Folic acid antagonist. Cancer chemotherapeutic drug. Used in the treatment of severe psoriasis and rheumatoid arthritis.	A+	Known human teratogen; usually involving the skull, central nervous system, or bone formation. Also affects male and female fertility. Transferred in small amounts to human milk.
Methoxychlor 72-43-5	Organochlorine insecticide used to control a wide variety of insects affecting fruits, vegetables, forage crops, and livestock.	B+*	No human studies. Male and female reproductive toxicity and developmental toxicity demonstrated in experimental animals, probably reflecting estrogenic activity.
Methyl Ethyl Ketone (MEK) 78-93-3	Organic solvent. Workplace exposure usually occurs with other solvents. Used in resins, paint removers, cements, adhesives. Used in the production of smokeless powder and in the surface coating industry.	A–	No human studies. Developmental toxicity in animals only in the presence of maternal toxicity.
Methyl Methacrylate 80-62-6	Used in the production of polymethyl methacrylate. Polymethyl methacrylate is used in acrylic sheet and acrylic molding, extrusion powder, acrylic surface coatings, printing inks, impregnation of concrete, and adhesives used in surgery and dentistry.	B–	No adverse effects on human reproductive function. Developmental toxicity noted in laboratory rat studies.
Methyl Parathion 298-00-0	Organophosphate insecticide. Cholinesterase inhibitor. Used primarily to kill boll weevils, mites, and tadpole shrimp.	A–	One report links methyl parathion exposure with birth defects in humans. Fetotoxic and teratogenic in several animal species, usually at doses that produced maternal toxicity.
Methylene Chloride 75-09-2	Halogenated organic solvent metabolized to carbon monoxide. Major industrial chemical with uses as an aerosol propellant, paint remover, metal degreaser, insecticide, and blowing agent for foams.	A+	Reports of methylene chloride exposure and spontaneous abortion, low birth weight, and central nervous system defects in humans. Found in human fetuses and human breast milk.
Methylformamide, N 123-39-7	Intermediate in the production of agrochemicals. Solvent.	B+*	No human data found but demonstrated to be teratogenic in several animal species.
Methylpyrrolidone (N-methyl-2-pyrrolidone) 872-50-4	Solvent used in chemical processing, chemical reaction medium/intermediate. Used as a pigment dispersant, spinning agent for polyvinyl chloride, solvent for coatings. Used in petroleum processing and in stripping and cleaning microelectronic components.	B+	No human studies. Fetotoxic and teratogenic in mice and rats at high doses.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Nickel 7440-02-0	Lustrous white, hard metal. Used in the production of stainless steel and over 3000 corrosion resistant alloys. Used in electroplating and synthetic chemistry. Used as a catalyst in the hydrogenation of fats and oils. Used in surgical and dental prostheses, coins, batteries, paint and ink pigments, ceramics, and glass. Used in welding.	B	No human studies. Some nickel compounds are embryotoxic or teratogenic in experimental animals. Nickel is capable of crossing the placenta.
Nitrous Oxide 10024-97-2	Used as an anesthetic agent in dentistry and surgery. Used as a propellant gas in food aerosols and other products. Used in leak detection. Used to oxidize organic compounds. Used to make nitrites from alkali metals. Used in rocket fuels and in the preparation of whipped cream. In its liquid form it is used to freeze foods and manufacture chemicals.	A–	Reports of reduced fertility, spontaneous abortions, and developmental defects of the musculoskeletal and nervous systems in humans.
Noise	Noise is prevalent in many workplaces. Examples include petroleum, lumber, food processing, furniture making, metals, rubber, plastics, construction, and air travel industries.	A–	Effects on human reproduction uncertain; intense noise may act as a non-specific stressor. A variety of reproductive effects have been noted in experimental animals, but not birth defects.
Oral contraceptives	Medication to prevent pregnancy. Pharmaceutical industry.	A–*	Equivocal studies on human reproduction and development; positive studies have been criticized on methodological grounds.
Ortho-Dichlorobenzene 95-50-1	One of three dichlorobenzene isomers. Solvent. Used as an insecticide for termites and locust borers. Used as a deodorizing agent in wastewater treatment. Used as a metal degreaser and polish, heat transfer medium, chemical intermediate, herbicide. Used in rust-proofing and wood preserving. Used to desulfurize gases.	A–	One unconfirmed report of ortho-dichlorobenzene inducing methemoglobinemia in humans. Not thought to be teratogenic in rats or rabbits.
Paints	General term that includes paints coatings, varnishes, shellacs, enamels, thinners, and strippers. Paints include pigments and may include solvents, alcohols, ketones, esters, glycol ethers, and acetates. Paints may also include phenyl mercurials to inhibit molds and fungus; insecticides; and organometallic drying agents.	A–	Reports of miscarriages and central nervous system defects in humans. Several ingredients of paints, including lead and methylene chloride, are known reproductive hazards. When possible the specific type of paint should be evaluated for reproductive toxicity.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Parathion 56-38-2	Toxic organophosphate insecticide. Restricted use pesticide in the USA. Indirect cholinesterase inhibitor.	B+	No human studies. May reduce fertility in experimental animals; embryotoxic and fetotoxic.
Parvovirus B19, Human	Etiologic agent of erythema infectiosum or fifth disease. The virus is spread by respiratory secretions and direct contact with infected individuals. Potential for exposure in health- and child-care settings and schools.	A*	Adverse pregnancy outcomes noted in infected women.
Perchloroethylene (PCE, PERC, Tetrachloroethylene) 127-18-4	Solvent. Used as a dry-cleaning agent, degreaser, fungicide, insecticide, and nematocide. Used in electroplating, machine shops, print shops, and assembly plants.	A–	Isolated reports of an increased risk of central nervous system and structural defects in the offspring of women occupationally exposed to PCE and other chemicals. Menstrual abnormalities. Inconsistent findings regarding workplace exposure and an increased risk of miscarriage. Found in milk of exposed human mothers.
Phenol (Carbolic Acid) 108-95-2	Hydroxylated derivative of benzene. Solvent, disinfectant. Used in phenolic resins, explosives, fertilizers, coke, paints, rubber, wood and other preservatives, textiles, drugs, and perfumes. Component of non-prescription products, including topical and oral anesthetics. Used in the plastics and chemical industries.	A+	Associated with methemoglobinemia in human infants. Reports of induced abortions, altered sex ratios, and impotence in humans. Embryotoxic/fetotoxic but not teratogenic in experimental animals.
Polybrominated Biphenyls (PBBs)	Used as a flame retardant (Firemaster).	B*	No evidence of reproductive- or developmental-toxicity in humans. Mixed findings in experimental animals regarding teratogenicity and neurobehavioral effects.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Polychlorinated Biphenyls (PCBs) 1336-36-3	Refers to a group of more than twenty lipid soluble chemicals. Were usually found in mixtures. Former uses: First used in nonflammable dielectric fluids for transformers, capacitors, and electric cables. Later used to produce fluid insulators for small electrical parts. Used in microscope immersion oil, pigment suspension vehicles for non-carbon duplicating paper, in printer's ink, ham radio dummy loads, and cutting oils. Used as solvent dispersants for pesticides, paints, plasticizers, hydraulic fluids, lubricants, adhesives, synthetic resins, varnishes, and waxes. Used as protective coating sealants for wood, automobile bodies, concrete, asphalt, and brake linings. Present uses: Microscopic immersion fluids, analytic reference standards, and in research. Exposures occur in utilities work, waste materials handling, fire fighting, and plastics, wax, and adhesives manufacturing.	A+	Teratogenic in humans. Associated with hyperpigmentation, skeletal anomalies, neurodevelopmental deficits, neonatal behavioral abnormalities, poorer recognition memory and performance on infant cognitive function tests, low birth weight, and premature birth. Male and female reproductive toxicity. Spontaneous abortion PCBs are found in human milk. Depressed fertility, spontaneous abortion, stillbirth, postnatal skin lesions, intoxication, and death seen in experimental animals.
Polyvinyl Chloride (PVC Resin) 9002-86-2	White thermoplastic material. Available as film, fibers, lacquers, monofilaments, powder, pellets, granules, extruded forms, and sheets. Used as a rubber substitute, in thin sheeting, upholstery, tubing, belting, gaskets, piping, flooring siding, and household products.	A–	Workplace studies indicate that PVC exposure may result in female reproductive toxicity, miscarriages, or stillbirths.
Potassium Silver Cyanide 506-61-6	Complex cyanide compound used in silver electroplating extracting silver from its ores. Used in the manufacture of antiseptics. Bactericidal agent.	A–	No human or experimental animal studies found. Listing based on toxicity information for cyanide.
Resmethrin 10453-86-8	Pyrethroid insecticide. Acts on a wide variety of insects. Used as a contact insecticide in industrial and household settings.	E	No human studies. Large doses produced resorptions and embryotoxicity in rats, but not teratogenicity.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Ribavirin (Virazole)	Antiviral agent generally administered as an aerosol. Used in health care settings; special concern about hospital staff exposures.	B+*	No evidence of reproductive or developmental toxicity in humans. However, studies of blood and urine levels in nursing staff suggest that health care workers who are pregnant or may become pregnant should be aware of potential hazards. Demonstrated to elicit reproductive effects, teratogenicity and embryolethality in several experimental animal species.)
Rubella (German measles)	Viral illness. Acquired via respiratory droplet inhalation. Potential for exposure in health- and child-care settings and schools.	A*	Well documented human teratogen. Offspring is most affected when mother is exposed during the first sixteen weeks of pregnancy. Produces congenital rubella syndrome, which may include congenital heart disease, deafness, cataracts, intrauterine growth retardation, encephalitis, thrombocytopenia, radiographic changes in the long bones, persistence of the virus in the infant. Effects in the infant may be thrombocytopenia purpura, hepatosplenomegaly, and obstructive jaundice. Effects as the individual ages may be short stature, mental retardation, neurological deficits, and behavioral abnormalities. Deterioration of hearing and mental functioning may appear in those not formerly thought to be affected. Successful maternal immunization greatly decreases incidence of congenital rubella syndrome.
Selenium 7782-49-2	Essential trace element. Used as a rubber additive, insecticide, catalyst, and animal feed additive. Used in rectifiers, glassmaking, steel, copper alloys, xerography, paints, varnishes, photocells, electrodes, and electrical instruments and apparatus. Used in solar cells, xerographic plates, magnetic copper cores, ceramics, rubber accelerators, and some anti-dandruff shampoos.	A–	Unconfirmed reports of workplace exposure and miscarriages, birth defects, and menstrual disorders. Selenium is found in human milk and crosses the placenta.

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Solvents	Extensive class of chemicals used to dissolve, suspend, or clean other chemicals. Difficult to analyze effects because a worker will often encounter many different solvents or mixtures of solvents in the workplace. Used in degreasing, maintenance, and cleaning operations. Used in painting, printing, dry cleaning, pesticide application. Used in shoe, rubber, and foam manufacture.	A–	Association between parental solvent exposure and fetal solvent syndrome. The developing central nervous system seems particularly vulnerable. Associations between exposure to solvents and an increased risk of miscarriages and birth defects, central nervous system defects, and craniofacial malformations being most common. Reports of menstrual disturbances and impotence. Many solvents may reach the embryo or fetus by crossing the placental barrier. Many solvents may reach human milk.
Styrene (Vinyl benzene) 100-42-5	Hydrocarbon. Used in the manufacture of plastics, synthetic (butadiene-styrene) rubbers, and polyester resins. Used in reinforced plastics (fiberglass). Used for boat building.	A–	Reports of menstrual dysfunction, miscarriages, birth defects, and effects on sperm production. Styrene may cross the placenta. Trace amounts have been detected in human breast milk.
Sulfur Dioxide 7446-09-5	Gas. Used as a chemical reducing agent and solvent. Used in bleaching, fumigating, disinfecting, and extraction of lubricating oils. Used in ore and metal refining. Used to treat wood pulp.	A–	Mixed exposures associated with abnormal pregnancies, miscarriages, and gynecological disease in women. Disruption of the estrus cycle, decreased female fertility, low fetal weight, and some structural malformations have been produced in experimental animals.
Tellurium 13494-80-9	Metallic element. Used as a metallurgical additive and a catalyst. Used in alloys, daylight lamps, semiconductors, vulcanization of rubber, pottery glazes, metal finishing, explosives, and antioxidants. Used in thermo-electric and electronic devices.	B–	No human data. Elicits hydrocephalus and central nervous system defects in rodents.
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) 1746-01-6	Most toxic and most prevalent of the dioxins. Formed during incineration and combustion, chemical manufacturing processes, industrial and municipal processes involving bleaching or municipal sludge. Formed in the manufacture of chlorophenols and phenoxy herbicides, chlorine-bleaching process of paper pulp, and in incineration of organic waste containing chlorine. Formed during the manufacture of 2,4,5-trichlorophenoxyacetic acid, an herbicide and component of Agent Orange.	A–	Equivocal reports of spontaneous abortions, birth defects, and problems with male fertility in humans. Concentrated in human milk fat. Reproductive and developmental toxicity observed in laboratory animals.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
TOCP (tri-ortho-cresyl phosphate) 78-30-8	Organophosphate compound. Isomer of tricresyl phosphate. Used as a plasticizer for polyvinyl chloride (PVC), polystyrene, lacquer, varnish, and nitrocellulose. Used as a plastic fire retardant, waterproofing compound, and hydraulic fuel. Used in air filter mediums, lubricants for use under high pressure, heat-stable lubricating oils, and synthetic fibers. Chemical intermediate in pharmaceutical manufacturing.	B–	No human studies. Can damage the testes of experimental animals. Degenerative changes in the ovaries and testes of exposed rats, including increased abnormal sperm and reduced numbers of sperm.
Toluene (Methyl Benzene) 108-88-3	Organic solvent and chemical intermediate. Used in paint and paint thinners, inks, cleaning agents, coatings, adhesives, rubber, fuel blending. Widely used in paint, printing, electronics, leather, and adhesives industries.	A+	Children of women who abused toluene experienced physical and developmental abnormalities such as low birth weight, microcephaly, broad nasal passage, and growth and developmental delay. Effects from abuse may not represent those likely from workplace exposure. Menstrual abnormalities.
Toxaphene (Camphechlor) 8001-35-2	Organochlorine insecticide. Cyclodiene compound. Complex mixture of over 117 polychlorinated C10 substances derived from camphene. No longer produced in the US. Scabies control in cattle is its only registered use.	B+	No human data. Has been detected in human milk. Multiple reproductive and developmental effects in laboratory animals.
Toxoplasmosis	Caused by the intracellular protozoan parasite, *Toxoplasma gondii*. Acquired through inadvertent fecal-oral contact. Potential for exposure in animal-care settings and the meat processing industry.	A*	Demonstrated risk to children born to women who were infected during pregnancy. Spontaneous abortion. Offspring of infected women may suffer encephalitis and/or hydrocephalus with calcification within the brain, chorioretinitis with scarring and loss of vision, hepatitis, and lymphadenopathy. Deafness, blindness, cerebral palsy, microcephaly, and low IQ may appear years later in those children born seemingly normal.
1,1,1-Trichloroethane 71-55-6	Chlorinated hydrocarbon solvent. Used as a solvent, degreaser, and insecticidal fumigant. Used in textile processing.	B	Not demonstrated to be a reproductive or developmental toxicant in humans. Low fetal weights, delayed development of bones and kidneys, fetotoxicity, and abnormalities of the cardiovascular system seen in experimental animals.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Trichloroethylene (TCE) 79-01-6	Used in the manufacture of pentachloroethane, poly-vinyl chloride (PVC), other polychlorinated aliphatic hydrocarbons, insecticides, flame retardants, dyes, disinfectants, pharmaceuticals, perfumes, and soaps. Used in oil processing, printing, textile and fabric cleaning, degreasing operations, drycleaning. Used in the preparation of adhesive materials, paints, and lubricating oils.	A–	Conflicting reports of male and female reproductive toxicity, miscarriages, birth defects, and growth retardation in humans. Trichloroethylene crosses the placenta.
Trinitrotoluene (TNT) 118-96-7	Used in the manufacture and use of explosives.	A–*	Reports of male reproductive toxicity in workers exposed to levels above the maximum allowable concentration (1 milligram/ cubic meter).
Triple Super Phosphate, Granular (TSP) 7758-23-8	Hydrated form of calcium diphosphate. Used as a commercial fertilizer. Anhydrous form is used as a food additive.	A–	Two Russian reports of gynecological problems in female superphosphate workers. Calcium and phosphate are required for normal development of the fetus and TSP is not thought to be a hazard to female reproduction.
Varicella-zoster virus	Virus that causes chicken pox (varicella) and herpes zoster (shingles). Acquired by the airborne route. Very contagious. Potential for exposure in health- and child-care settings and schools.	A*	Birth defects and growth retardation observed in offspring of women infected during pregnancy.
Vinclozolin 50471-44-8	Dicarboximide fungicide used on food and ornamental plants.	B–*	No human data. Male reproductive toxicity in experimental animals.
Vinyl Chloride Monomer (VCM) 75-01-4	Starting material in the manufacture of many building, construction, automotive, household, and medical products. Result of the out-gassing of PVC in new cars, packaging and PVC pipes. Formerly used as a refrigerant, aerosol propellant, and anesthetic gas.	A–	Several unconfirmed reports of human effects. Occupational/environmental exposures associated with birth defects, fetal loss, loss of male libido, and decreased spermatogenesis.
Warfarin 81-81-2	Widely used rodenticide and medication (inhibits the clotting of blood).	A+	Causes structural malformations, central nervous system defects, mental retardation, developmental delays, and spontaneous abortions in humans at therapeutic doses. Any workplace exposure to pregnant women strongly discouraged.
Xylene 1330-20-7	Solvent and chemical intermediate. Solvent in paints, lacquers, coatings, thinners, paint removers, and lacquers. Used in insecticides, gasoline, and leather products.	A–	Reports of birth defects and menstrual disturbances in humans. Xylene crosses the placenta in humans and is found human milk.

Key to REPROTEXT® classifications on last page of table

Exposure/Chemical CAS Number	Occupational Uses/Exposures	REPROTEXT® Classification	Reproductive/Developmental Outcome
Zinc and Zinc Salts 7440-66-6	Soft bluish-white metal and its salts. Zinc is an essential human nutrient and is necessary for normal reproduction. Used in alloys, soldering, fluxes, galvanized steel and iron, wood preservatives, deodorants, adhesives, petroleum refining, organic synthesis, textile processing, dental cements, feed additives, corrosion inhibitors, astringents, and smoke generators.	F	The human requirement for zinc increases during pregnancy. Zinc DEFICIENCY may cause birth defects, however supplements should not be taken in excess of that directed by a physician.

Key to REPROTEXT® classifications:

A+ Human reproductive hazard with no known no-effect dose.
A Human reproductive hazard with known no-effect dose.
A– Unconfirmed human reproductive hazard.
B+ Multiple reproductive effects in animals, no human data.
B Mixed reproductive effects in animals but no human data.
B– Few reproductive effects in animals but no human data.
C No reproductive data found.
E Known not to affect animal reproduction but no human data.
F Known not to affect human reproduction.
***** Rating not available in REPROTEXT® database; rating applied by authors of this booklet and based on available data.

REPROTEXT® data reprinted with permission: Hall, A.H. (Ed): REPRORISK® System. MICROMEDEX, Inc., Englewood, Colorado (Volume 99, expires February 28, 1999).

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Appendix B

Sample Letter Requesting Material Safety Data Sheets

Date

Manufacturer/Distributor
Address
City, State, Zip Code

Subject: Material Safety Data Sheet

Please send us a Material Safety Data Sheet (MSDS) for the products below:

1.
2.
3.

The MSDS is for our hazard communication program required by the Hazard Communication Standard. Please make sure each MSDS meets the requirements of WAC 296-62-054, Hazard Communication Standard (equivalent to 29CFR 1910.1200, OSHA Hazard Communication Standard). Washington recognizes a complete and accurate OSHA Form 174 MSDS as complying with state requirements.

Thank you for your assistance

Sincerely,

Appendix C

Sample MSDS

MSDSs are prepared by the chemical manufacturers and are of variable quality. While very few include adequate information about reproductive health effects, they are helpful in identifying the names of most chemicals. This makes the MSDS a useful first step in the search for additional information.

The MSDS is usually presented on a form containing eight or nine sections. Below is a sample MSDS form and a brief description with particular attention to the sections useful in assessing reproductive and developmental risk.

The following information is adapted from "Reproductive Hazards in the Workplace," a syllabus for clinicians written by Maureen Paul, MD, MPH, FACOG and Sabrina Kurtz, MEd University of Massachusetts Medical Center Occupational and Environmental Reproductive Hazards Center, April 1990.

SECTION 1: PRODUCT IDENTIFICATION

Product identification by formal chemical name, trade name, chemical family and chemical formula. In addition, manufacturer's name, address, telephone number, date of MSDS preparation or revision, and an emergency phone number.

If the product contains a single chemical, the formal chemical name is the best identifier. If it is a chemical mixture, the chemical family and list of hazardous ingredients is used for identification.

If you need the name of a "trade secret" chemical (see Section II) or think the MSDS is outdated or inadequately prepared, do not hesitate to call the manufacturer. Ask for the research or safety department in order to speak with those responsible for MSDS preparation.

SECTION II: HAZARDOUS INGREDIENTS

Listing of ingredients for products that contain a mixture of hazardous chemicals. Listing is by chemical name and Chemical Abstract Service (CAS) number. If available, the recommended air concentration exposure limit for each ingredient is provided.

Use exact spelling when researching a chemical because some chemicals have similar names but are very different. Since each chemical has only one CAS number, this number is the best **identifier for research purposes.**

Ingredients that are non-threatening to human health, present in too small a concentration to cause harm or approved as a "trade secret" will not be listed. "Trade secret" or "proprietary formulation" means that revealing the chemical formula may provide other competitive companies with an advantage. Health Professionals can obtain this information by a phone call or written request to the manufacturer.

The Threshold Limit Value (TLV) is the non-enforceable recommended limit of the American Conference of Governmental Hygienists. The Permissible Exposure Limit (PEL) is the legally

enforceable limit under the Washington State Industrial Safety and Health Act (WISHA). Recommended exposure limits may be helpful in assessing a patient's risk when a workplace air sample report can be obtained. Unfortunately, most recommended limits are not based on adequate consideration of reproductive effects. Limits are expressed as parts per million parts of air by volume (ppm) or milligrams per cubic meter of air (mg/m^3). The conversion equation is:

$$1\ ppm = \frac{MW\ (mg/m^3)}{24.45}$$

(MW = molecular weight)

SECTION III: PHYSICAL DATA

Information regarding the physical state of the product (solid, liquid or gas). Information regarding the product's physical properties is useful for determining how the chemical enters the body.

Three characteristics indicate how readily a liquid will evaporate and present a potential inhalation hazard - boiling point, vapor pressure and percent volatility. In general, chemicals with low boiling points, high vapor pressures or high percent volatility by volume are likely to be inhalation hazards. Evaporation Rate indicates how fast a substance will evaporate as compared to butyl acetate (evaporated slowly) or ether (evaporates quickly). A rate greater than one indicates that the product evaporates quicker than the standard substance; a rate less than one indicates that it evaporates more slowly. It is important to keep in mind that agents with low rates of evaporation may still be absorbed through the skin.

Other descriptors include Solubility in Water - the percent by weight that can be dissolved in water; Melting Point - the point at which a solid becomes a liquid; and Specific Gravity - a comparison of the weight of the substance to an equal weight of water at 39.2 degrees Fahrenheit. Chemicals with a specific gravity greater than one sink in water, while those with less than one rise.

Appearance and Odor designate chemical properties that may allow for sensory recognition of the product in the workplace. However, odor is often a poor indicator of the amount of a substance in the air. Some hazardous agents, such as carbon monoxide, have no odor; others such as hydrogen sulfide, cause olfactory paralysis (loss of sense of smell). Workers may become accustomed to smells over time, thereby allowing a chemical to reach a hazardous level without being noticed.

SECTION IV: FIRE AND EXPLOSION HAZARD DATA

Information on how to avoid and contain fires involving the product.

This is an important section for assuring the general health and safety of the worker.

Flash Point indicates the temperature at which ignition occurs. A substance with a flash point near or below room temperature is very dangerous and can easily be ignited by a spark, cigarette, or match.

Flammable and Explosive Data indicate the amount of vapors necessary for ignition. A value between the low explosive limit (LEL) and the upper explosive limit (UEL) can ignite.

Extinguishing Media and Procedures describes the special materials and equipment needed to extinguish a fire.

SECTION V: HEALTH HAZARDS DATA

Description of potential health hazards of a product.

Despite its importance, this section of the MSDS is often limited. Effects of overexposure may describe the routes of entry into the body and possible symptoms. Acute and chronic effects may be described. Remember, reproductive risks are rarely mentioned. It is therefore important to research the reproductive effects of the ingredients listed in Section II by using chemical and medical reference books and online computer databases. Emergency and First Aid Procedures are listed, but medical consultation should be obtained after any accident.

SECTION VI: REACTIVITY DATA

Description of possible chemical reactions of ingredients with other substances.

Conditions to Avoid are noted along with a list of Incompatible Substances. Hazardous Decomposition Products describes potentially harmful reaction byproducts.

SECTION VII: SPILLS OR LEAK PROCEDURES

Information on how to handle chemical spills.

This is essential to the health and safety of the worker. Again, the information presented in the MSDS on this subject may be limited. Emergency response personnel can be important sources of information regarding exposure due to accidents.

SECTION VIII: SPECIAL PROTECTIVE INFORMATION

Information about recommended protective equipment and safety practices when working with the chemical.

In assessing worker exposure, consider the quality, availability, practicality and usability of equipment and controls. Take note of ventilation systems, protective clothing, such as gloves and eye wear, and other protective equipment, such as respirators. Discuss workplace hygiene practices, particularly when smoking or eating in contaminated areas can lead to increased absorption.

Appendix D

Estimating Workplace Exposure

This questionnaire is for men and women who use chemicals at work or may be exposed to other hazardous conditions.

Instructions for Workers:
Collect the information you need to complete these questions. Share the information 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, your fertility 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 or other occupational health specialist.

1. What is your current job title? (If you are not currently working, or have changed jobs in the last year, where were you last employed and what was your job title?)

_____

2. Describe the tasks or activities you perform at work.

_____

_____

_____

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

_____

_____

_____

4. How many hours per week do you work? _____ hours

5. Do you work rotating shifts? Yes ____ No ____

6. Write the names of any chemicals you work with in the column at the left. If you use more than one, list them in order of how frequently you use them. Put the one you use most frequently in the top space.

In the column on the right, describe how you use each chemical. Write when and for how long you use them. For example, "twice a day for ten minutes each time." Also, write how much of each chemical or product you use each time you work with it, for example, "1-2 gallons."

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 the product. A sample MSDS and a letter requesting an MSDS are in Appendices B and C, respectively. Employers are required by law (WAC 296-62-054 through -05427) to provide workers with a copy of the MSDS, upon request. Employers must also provide this information to a treating doctor on request.

	Chemical Name	How, when I use them, and how much I use
Most Freq-Used		
Least Freq-Used		

7. In your work area, how many other people also use these chemicals?_____

8. Besides the chemical that you work with, what other chemicals do people in your area use?

9. List any of these chemicals that you or other workers in your area use that are heated. Also, write the temperature to which they are heated.

Chemicals that are heated	Temperature

10. Can you smell or taste any chemical fumes or vapors where you work?

If yes, list them by chemical name.

11. Do you feel sick when you work with any of the chemicals? If yes, list which chemicals in the column on the left. In the column on the right, describe how you feel when you work with each chemical.

Chemicals	Symptoms

12. If working with any chemicals makes you sick, do you feel better at other times? Yes _____ No _____ If yes, please explain when it is you feel better.

_____

_____

13. If you are pregnant, did you have these symptoms before becoming pregnant? Yes ____ No ____

14. List any of the chemicals that you work with that get on your skin.

_____

_____

_____

15. Do you do any of the following in the work area?

EAT	Yes ____ No ____
DRINK	Yes ____ No ____
SMOKE	Yes ____ No ____
APPLY MAKEUP	Yes ____ No ____

The following questions are about protective measures used in your workplace.

16. Mark the type of VENTILATION used in your work area

_____ hood with power exhaust
_____ general ventilation (wall fans, roof fans, ceiling vents)
_____ natural ventilation (open windows and doors)

17. Do you think the ventilation is effective in reducing your exposure?
Yes ____ No ____

18. Is the ventilation always turned on when you are using chemicals?
Yes ____ No ____

19. Does the ventilation usually work well? Yes ____ No ____

20. Are hand-washing facilities available? Yes ____ No ____

21. Are showering facilities available? Yes ____ No ____

22. Describe the types of PROTECTIVE CLOTHING you wear on the job.

Type of Gloves
_____

Type of Apron/Coat
_____

Type of Eyewear
_____

Ear Protection? Yes ____ No ____

23. Do chemicals leak through your gloves or clothing? Yes ____ No ____
If yes, explain
_____

24. Mark the kind of RESPIRATORY PROTECTION you use on the job.
____ paper dust mark
____ paper mask with filter
____ half-face mask with cartridges
____ full-face mask with cartridges
____ air-supplied respirator

If you wear a cartridge respirator:

25. What kind of cartridge? _____

26. When do you wear a respirator? _____

27. For what chemicals do you wear a respirator?

---

28. Have you been fit-tested and trained to use your respirator?
Yes ____ No ____

29. Have you received instructions about changing your cartridges and other maintenance?
Yes ____ No ____

30. 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?
Yes ____ No ____

If yes, explain_____
_____
_____
_____

31. What types of instructions and warnings has your employer given you about the use of chemicals?

_____

32. Have the air levels of chemicals in your work area been measured?
Yes ____ No ____

If monitoring has been done, you have a legal right to see the results relevant to your work area (WAC 296-62-052). If you are a member of a union, the union can help you enforce this right.
If you know the results, write them here.

_____
_____
_____
_____

33. Do you wear your own street clothes at work? Yes ____ No ____

34. Are there laundry facilities at work for contaminated clothing? Yes ____ No ____

35. Do you do any other work outside your regular job, or have any hobbies, which involve exposure to chemicals? Yes ____ No ____ If yes, describe them:

_____
_____
_____
_____

36. Is there a medical surveillance program at work? Yes ____ No ____

37. If you are involved in any of the following physical activities on the job, please describe them and write how many hours per day you perform each below.

Description **Hours/day**

Lifting

_____

Climbing

_____

Bending

_____

Twisting

_____

Sitting

_____

Standing

_____

38. If you are exposed to any of the following on your job, describe them by writing when, how often and how much you are exposed to each:

Noise

_____

Vibration

_____

Temperature Extremes

_____

Radiation

_____

Infectious Agents

_____

Psychological Stress

_____