

# RADIATION EXPOSURE AND PREGNANCY

## Introduction

The developmental risks associated with radiation exposure to an unborn child during gestation are the focus of this training information. However, you must understand that even under normal physiological conditions, the healthy development of a child is not a 100% guarantee. There are many factors that can affect the healthy conception and development of children. In addition to radiation exposure, some of the other factors may include poor nutrition, age, heredity, certain chemicals, certain drugs (legal and illegal), cigarettes, some viruses, alcohol, and many other factors. Everyone is exposed to these factors at work, at home, for medical diagnosis or treatment, or in the community. These factors can cause reproductive or developmental problems such as infertility, miscarriage, birth defects, low birth weight, abnormal growth and development, and childhood cancer.

As you complete this training, keep in mind that there are many factors in your environment that may affect the development of your child. Occupational exposures to radiation are of minimal increased risk when the UMMC safety polices are adhered to and regulatory limits are maintained in accordance with the institutional ALARA program. The UMMC Radiation Safety Office closely monitors fetal exposures to assure they are below the limitations specified in the regulations. Institutional policies are in place to assure the workplace environment is safe for occupationally exposed workers and their unborn children, and efforts shall be made to keep prenatal exposures below the maximum permissible dose.

## Background

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 28<sup>th</sup> 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 has not been determined to any degree of certainty. However, it is certain that some workplace chemicals and physical factors may cause certain adverse effects. 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 (relative to the development of the fetus).

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.

### **UMMC Prenatal Radiation Exposure Policy for Employees**

It is the responsibility of all women of childbearing age who wish to declare their pregnancy to notify their supervisor or the UMMC Radiation Safety Office as soon as they know or, even suspect that they may be pregnant if their duties involve working in areas where radiation sources are used or stored. A woman who wishes to declare her pregnancy must complete [the UMMC Declaration of Pregnancy Form](#), Attachment E to the UMMC Radiation Safety Manual, and return it to the UMMC Radiation Safety Office. A video, "The Pregnant Worker", is on file at the circulation desk in the library for review by all pregnant workers at risk of exposure to radiation.

It is the institutional policy to transfer the employee to a working environment where occupational radiation exposure is negligible. However, it is important to note that an employer cannot force an employee to transfer jobs, resign or take unpaid leave. A pregnant employee may request to remain in her current position whether or not the radiation exposure history shows doses below the maximum permissible dose. Neither can the employee provide the employer with a waiver of liability as a condition of remaining on the job.

If the employee chooses to remain in a position where a radiation exposure potential exists, the department will request an additional radiation-monitoring device for the fetus to monitor prenatal exposures. The fetal monitor shall be worn on the abdomen of the mother, behind a lead apron if one is required. If over-exposure potential is great, a personal dosimeter will be provided for daily determination of exposure levels.

### **Exposure Limits**

Everyone is exposed to radiation every day. People are continuously exposed to low-level radiation found in food, soils, building materials, the air, and from outer space. All of this radiation originates from naturally occurring sources. For example, bananas contain naturally occurring radioactive potassium-40 and air contains radon, a radioactive gas. Your "average natural background" radiation dose is about 300 millirem each year. In addition to natural background

radiation, you may be exposed to radiation from medical x-rays and medical radiation tests or treatments throughout each year.

As an occupational worker in an area where sources of radiation are used, you may be exposed to more radiation than the general public. The amount of radiation an occupationally exposed worker is allowed to receive is 5,000 millirem per year.

Individuals under the age of 18 and members of the general public are only permitted to be exposed to 500 millirem per year, which is one-tenth of the annual limit of an occupationally exposed adult. The amount of radiation a fetus is allowed to receive is 500 millirem during the entire gestation period, not to exceed 50 millirem in one month<sup>1</sup>.

### **Prenatal Effects of Radiation**

As an individual whose occupation requires that you work directly with radiation sources or at times work in locations designated as restricted areas, it is important that you have a basic understanding of potential biological effects to an unborn baby associated with prenatal radiation exposure.

The possibility of health effects depends on the gestational age of the unborn baby at the time of exposure and the amount of radiation it is exposed to. Unborn babies are less sensitive to radiation during some stages of pregnancy than others. Unborn babies are particularly sensitive to radiation during their early development, between weeks 2 and 15 of pregnancy. However, since the baby is shielded by the mother's abdomen, the radiation dose to the unborn baby is lower than the dose to the mother for most radiation exposure events.

A pregnant woman who accidentally swallows or breathes in radioactive materials may absorb that substance into her bloodstream. From the mother's blood, radioactive materials may pass through the umbilical cord to the baby or concentrate in areas of the mother's body near the womb (such as the bladder) and expose the unborn baby to radiation.

Unborn babies are especially sensitive to the cancer-causing effects of radiation. However, the increased risks depend on the amount of radiation to which the baby was exposed and the amount of time that it was exposed. For example, if the radiation dose to the unborn baby was roughly equivalent to 500 chest x-rays at one time, the increase in lifetime cancer risk would be less than 2%<sup>2</sup> (above the normal lifetime cancer risk of 40-50%).

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<sup>1</sup> The National Council on Radiation Protection and Measurement recommended in NCRP Report No. 91 "Recommendations on Limits for Exposure to Ionizing Radiation" (June 1, 1987) that no more than 0.05 rem (0.5 millisievert) to the embryo/fetus be received in any one month.

<sup>2</sup> Excerpt from Centers for Disease Control web site article "Possible Health Effects of Radiation Exposure on Unborn Babies".

During the first 2 weeks of gestation the baby is made up of only a few cells. Damage caused to one of these cells can have a greater impact at this delicate stage than during later stages of gestation when the baby has more cells and damage to one cell is not such a large fraction of the baby's body. Damage to one of only a few cells can lead to the death of the baby before the mother even knows she is pregnant. "Of the babies that survive, however, few will have birth defects related to the exposure, regardless of how much radiation they were exposed to."<sup>3</sup>

Higher radiation doses (doses greater than that received from 500 chest x-rays) during sensitive stages of development, between weeks 2 and 15, can cause birth defects. The brain is particularly sensitive during this stage of development and brain damage may occur.

During the later stages of development, weeks 16-25, effects from low doses of radiation exposure are unlikely. Higher doses of radiation would be required to cause birth defects, but the doses would have to be greater than about 5,000 chest x-rays received at one time.

After the 26<sup>th</sup> week of gestation, the radiation sensitivity of the unborn baby is similar to that of a newborn baby. At the 26<sup>th</sup> week of pregnancy, the unborn baby is fully developed though not fully grown. This means that birth defects are not likely to occur, and only a slight increase in the risk of having cancer later in life is expected.

### **Decisions During Pregnancy**

It is your responsibility to decide whether the risks to you or to your unborn child are acceptable. It is up to you to compare the benefits of your employment against the possible risks involving occupational radiation exposure to a known or potential unborn child. You should know that the Pregnancy Discrimination Act, an amendment of Title VII of the Civil Rights Act of 1964, states that "... women affected by pregnancy, childbirth, or related medical conditions; shall be treated the same for all employment-related purposes, including receipt of benefits under fringe benefit programs, as other persons not so affected but similar in their ability or inability to work...." In addition, the Equal Employment Opportunity Commission (a Federal agency) is responsible for examining cases for compliance with this Act. Some facts listed below may be helpful in making this decision.

The first 3 months of pregnancy are the most important, so you should make your decision early.

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<sup>3</sup> Excerpt from Centers for Disease Control web site article "Possible Health Effects of Radiation Exposure on Unborn Babies".

In most work situations, the actual dose received by an unborn child would be less than the dose you would receive yourself because some of the dose would be absorbed by your body.

The dose to the unborn child can be reduced, where possible, by

Decreasing the amount of time you spend in an area where you will be exposed to radiation,  
Increasing the distance between yourself and the source of radiation, and  
Shielding your abdominal area.

If you do become pregnant, you can ask your employer to reassign you to areas involving less exposure to radiation for the duration of your pregnancy.

When your occupational exposure is below the 5 rems per year limit, the risk to an unborn child is small in relation to other day-to-day risks to the unborn child during pregnancy.

There is no need to be concerned about sterility, that is, loss of your ability to bear children. The radiation required to produce this effect is more than 100 times greater than the Nuclear Regulatory Commission's basic dose limits for adults of 5 rems per year.

### **Questions and Answers**

Listed below are some questions and answers excerpted from the Nuclear Regulatory Commission's (NRC) Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure".

Note: Each time the word "licensee" is used in this section consider this to mean the University of Mississippi Medical Center.

1. Why am I receiving this information?

The NRC's regulations (in 10 CFR 19.12, "Instructions to Workers") require that licensees instruct individuals working with licensed radioactive materials in radiation protection as appropriate for the situation. The instruction below describes information that occupational workers and their supervisors should know about the radiation exposure of the embryo/fetus of pregnant women. The regulations allow a pregnant woman to decide whether she wants to formally declare her pregnancy to take advantage of lower dose limits for the embryo/fetus. This instruction provides information to help women make an informed decision whether to declare a pregnancy.

2. If I become pregnant, am I required to declare my pregnancy?

No. The choice whether to declare your pregnancy is completely voluntary. If you choose to declare your pregnancy, you must do so in writing and a lower radiation dose limit will apply to your embryo/fetus. If you choose not to declare your pregnancy, you and your embryo/fetus will continue to be subject to the same radiation dose limits that apply to other occupational workers.

3. If I declare my pregnancy in writing, what happens?

If you choose to declare your pregnancy in writing, the licensee must take measures to limit the dose to your embryo/fetus to 0.5 rem (5 millisievert) during the entire pregnancy. This is one-tenth of the dose that an occupational worker is allowed receive in a year. If you have already received a dose exceeding 0.5 rem (5 mSv) in the period between conception and the declaration of your pregnancy, an additional dose of 0.05 rem (0.5 mSv) is allowed during the remainder of the pregnancy. In addition, 10 CFR 20.1208, "Dose to an Embryo/Fetus," requires licensees to make efforts to avoid substantial variation above a uniform monthly dose rate so that all the 0.5 rem (5 mSv) allowed dose does not occur in a short period during the pregnancy. This may mean that, if you declare your pregnancy, the licensee may not permit you to do some of your normal job functions if those functions would have allowed you to receive more than 0.5 rem, and you may not be able to have some emergency response responsibilities.

4. Why do the regulations have a lower dose limit for the embryo/fetus of a declared pregnant woman than for a pregnant worker who has not declared?

A lower dose limit for the embryo/fetus of a declared pregnant woman is based on a consideration of greater sensitivity to radiation of the embryo/fetus and the involuntary nature of the exposure. Several scientific advisory groups have recommended that the dose to the embryo/fetus be limited to a fraction of the occupational dose limit.

5. What are the potentially harmful effects of radiation exposure to my embryo/fetus?

The occurrence and severity of health effects caused by ionizing radiation are dependent upon the type and total dose of radiation received, as well as the time period over which the exposure was received. Refer to Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Exposure" (on file in the UMMC Radiation Safety Office), for more information. The main concern is embryo/fetal susceptibility to the harmful effects of radiation such as cancer.

6. Are there any risks of genetic defects?

Although radiation injury has been induced experimentally in rodents and insects, and in the experiments was transmitted and became manifest as hereditary disorders in their offspring, radiation has not been identified as a cause of such effect in humans. Therefore, the risk of genetic effects attributable to radiation exposure is speculative. For example, no genetic effects have been documented in any of the Japanese atomic bomb survivors, their children, or their grandchildren.

7. What if I decide that I do not want any radiation exposure at all during my pregnancy?

You may ask your employer for a job that does not involve any exposure at all to occupational radiation dose, but your employer is not obligated to provide you with a job involving no radiation exposure. Even if you receive no occupational exposure at all, your embryo/fetus will receive some radiation dose (on average 75 mrem (0.75 mSv)) during your pregnancy from natural background radiation. The NRC has reviewed the available scientific literature and concluded that the 0.5 rem (5 mSv) limit provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers. If this dose limit is exceeded, the total lifetime risk of cancer to the embryo/fetus may increase incrementally. However, the decision on what level of risk to accept is yours.

8. What effect will formally declaring my pregnancy have on my job status?

Only the licensee can tell you what effect a written declaration of pregnancy will have on your job status. As part of your radiation safety training, the licensee will tell you the company's policies with respect to the job status of declared pregnant women. In addition, before you declare your pregnancy, you may want to talk to your supervisor or your radiation safety officer and ask what a declaration of pregnancy would mean specifically for you and your job status. In many cases you can continue in your present job with no change and still meet the dose limit for the embryo/fetus. For example, most commercial power reactor workers (approximately 93%) receive, in 12 months, occupational radiation doses that are less than 0.5 rem (5 mSv) (Ref. 11). The licensee may also consider the likelihood of increased radiation exposures from accidents and abnormal events before making a decision to allow you to continue in your present job. If your current work might cause the dose to your embryo/fetus to exceed 0.5 rem (5 mSv), the licensee has various options. It is possible that the licensee can and will make a reasonable accommodation that will allow you to continue performing your current job, for example, by having another qualified

employee do a small part of the job that accounts for some of your radiation exposure.

9. What information must I provide in my written declaration of pregnancy?

You must provide, in writing, your name, a declaration that you are pregnant, the estimated date of conception (only the month and year need be given), and the date that you give the letter to the licensee. [A Declaration of Pregnancy](#) form letter that you can use is included in the UMMC Radiation Safety Manual. You may use that letter or write your own letter.

10. To declare my pregnancy, do I have to have documented medical proof that I am pregnant?

NRC regulations do not require that you provide medical proof of your pregnancy. However, NRC regulations do not preclude the licensee from requesting medical documentation of your pregnancy, especially if a change in your duties is necessary in order to comply with the 0.5 rem (5 mSv) dose limit.

11. Can I tell the licensee orally rather than in writing that I am pregnant?

No. The regulations require that the declaration must be in writing.

12. If I have not declared my pregnancy in writing, but the licensee suspects that I am pregnant, do the lower dose limits apply?

No. The lower dose limits for pregnant women apply only if you have declared your pregnancy in writing. The United States Supreme Court has ruled (in *United Automobile Workers International Union v. Johnson Controls, Inc.*, 1991) that "Decisions about the welfare of future children must be left to the parents who conceive, bear, support, and raise them rather than to the employers who hire those parents". The Supreme Court also ruled that your employer may not restrict you from a specific job "because of concerns about the next generation." Thus, the lower limits apply only if you choose to declare your pregnancy in writing.

13. If I am planning to become pregnant but am not yet pregnant and I inform the licensee of that in writing, do the lower dose limits apply?

No. The requirement for lower limits applies only if you declare in writing that you are already pregnant.

14. What if I have a miscarriage or find out that I am not pregnant?

If you have declared your pregnancy in writing, you must promptly inform the licensee in writing that you are no longer pregnant. However, if you have not formally declared your pregnancy in writing, you need not inform the licensee of your non-pregnant status.

15. How long is the lower dose limit in effect?

The dose to the embryo/fetus must be limited until you withdraw your declaration in writing or you inform the licensee in writing that you are no longer pregnant. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

16. If I have declared my pregnancy in writing, can I revoke my declaration of pregnancy even if I am still pregnant?

Yes, you may. The choice is entirely yours. If you revoke your declaration of pregnancy, the lower dose limit for the embryo/fetus no longer applies.

17. What if I work under contract at a licensed facility?

The regulations state that you should formally declare your pregnancy to the licensee in writing. The licensee has the responsibility to limit the dose to the embryo/fetus.

18. Where can I get additional information?

The UMMC Radiation Safety Office can provide more information on request. NRC's Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," and NRC's Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" is on file and can be copied for you.

**The University of Mississippi Medical Center  
Radiation Safety Office  
(601) 984-1078**

***Declaration of Pregnancy***

To: \_\_\_\_\_  
(Name of your supervisor)

In accordance with the Regulations for Control of Radiation in Mississippi, Section 400.13, "Dose to an Embryo/Fetus," I am declaring that I am pregnant. I believe I became pregnant in \_\_\_\_\_ (only the month and year need be provided).

I understand that my occupational radiation dose during my entire pregnancy will not be allowed to exceed 0.5 rem (5 millisieverts), (unless that dose has already been exceeded between the time of conception and submitting this letter). I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

Prior to being issued a fetal monitoring badge, a completed copy of this form must be submitted to the Radiation Safety Office. In addition, please notify the Radiation Safety Office if you find out that you are not pregnant, your pregnancy is terminated, or after the birth in order to discontinue the fetal monitoring badge.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Date