



Fermilab
ES&H Section

TO: Female Radiation Workers

FROM: Susan McGimpsey
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SUBJECT: Radiation Exposure to Unborn Children

It is known that an embryo/fetus is more sensitive to radiation than an adult. The specific reasons for this have been addressed in your radiological worker training. It is the intent of Fermilab that no pregnant woman will be exposed to radiation doses large enough to result in a significant risk to the embryo or fetus. To accomplish this, it is important that all female personnel who work in radiological areas be aware of the increased sensitivity of the fetus to radiation and the proper steps required to keep radiation exposures to a minimum.

Attached for your information are Fermilab policies on radiation exposure to unborn children and common questions and answers related to prenatal exposure. This information is provided so that women who become pregnant can make an informed decision on whether or not to formally declare their pregnancy.

Please be aware that the policies themselves are binding for Fermilab employees and can only be used as guidance for visitors and subcontractors. Visitors and subcontractors are highly encouraged to contact their employer to learn of their employer's prenatal policies. Members of the Radiological Control Organization will make themselves available to answer questions and address concerns regarding prenatal radiation exposure raised by any radiological worker. In addition, they will provide assistance in implementing prudent measures to minimize exposure of the unborn child.

If you have further questions or would like additional information, please contact your Radiation Safety Officer, the Fermilab Medical Office (X3232 or WH Ground Floor) or the Dosimetry Program Office (X8386 or WH7E).

FERMILAB RADIOLOGICAL CONTROL MANUAL

CHAPTER 9 SPECIAL CIRCUMSTANCES

PART 5 PRENATAL POLICY/PROCEDURES

951 Prenatal Policy and Procedures

Members of the Radiological Control Organization will make themselves available to answer questions and concerns regarding prenatal radiation exposure raised by any radiological worker. In addition, they will provide assistance in implementing prudent measures to minimize exposure of the unborn child. The requirements of this Article pertain only to Fermilab employees. To learn of options available to them, female employees of subcontractors or other institutions should contact their own employer. As appropriate, the following may be used as guidelines in outlining a course of action for employees of subcontractors or other institutions.

Fermilab has established a policy and appropriate procedures to allow a radiation worker to make a knowledgeable decision regarding the risk to her unborn child. Once a woman has been classified as a declared pregnant worker, the dose limit of 500 mrem to the embryo/fetus for the entire gestation period established in Article 213 applies.

If a woman knows or suspects that she is pregnant, she must choose one of the following options:

1. Choose not to notify the Medical Department in writing of her pregnancy. In this case, the usual occupational exposure limits will continue to be applied. Women who take this option should only do so with full awareness that they may be increasing the risk to their unborn child.
2. Voluntarily notify the Medical Department in writing as soon as possible. The documentation of declarations of pregnancy can be made on [R. P. Form 86](#) and distributed as stated on the form. At any time, the worker may, in writing, revoke this declaration.
 - a. After a female radiological worker voluntarily notifies Fermilab in writing that she is pregnant, she is considered a declared pregnant worker for the purpose of fetal/embryo dose protection. At this time, a radiation safety staff member will measure radiation levels in her work area(s) and estimate the exposure to the unborn child for the term.
 - b. After this evaluation is conducted, a Fermilab employee has the following options:
 - 1) Request a temporary reassignment to work in areas involving a lower potential for radiation exposure. If a transfer is recommended by the Medical Department and radiation safety, Fermilab shall make a reasonable attempt to find an assignment of equal pay and status for the employee.
 - 2) Ask for a leave of absence. Leaves of absence under such circumstances are subject to the requirements of the Personnel Policy Guide.
 - 3) Continue working at the same job assignment and reducing her exposure to less than 500 mrem throughout the duration of the pregnancy, where practical, by using shielding, increasing distances from radiation sources and decreasing the amount of time spent in radiation areas. Fermilab radiation safety personnel shall make recommendations to the woman's supervisor such that reasonable steps can be taken to minimize her radiation exposure.

4) Terminate employment at the Laboratory.

The option selected shall be documented and dated in writing and retained by the Medical Department.

- c. To learn options available to them, female users should contact the administrator of their sponsoring institution and female subcontractor employees should contact their own employer.

3. Declared pregnant worker:

- a. If the dose to the embryo/fetus is determined to have already exceeded 500 mrem when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks where additional occupational exposure is likely for the duration of her pregnancy.
- b. Efforts shall be made to avoid exceeding 50 mrem per month to the pregnant radiological worker. The worker shall be assigned a pocket dosimeter and wear it while working in controlled areas in order to monitor her dose on a monthly basis.
- c. Fermilab's dosimetry vendor offers the option of an additional badge for fetal monitoring. Pregnant workers who frequently work in non-uniform fields or in close proximity to radioactive materials such that the fetal dose might differ significantly from the pregnant worker's whole body dose are encouraged to use this option.

**INFORMATION FOR PREGNANT WOMEN
QUESTIONS AND ANSWERS**

1. What is the exposure limit for an embryo/fetus?

Section 835.206 of Title 10, Part 835, of the Code of Federal Regulations (10CFR835) mandates that "the dose equivalent for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem [500 mrem]." This regulation also requires Fermilab to make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant worker. A declared pregnant worker is defined in 10CFR835.2 is "a woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus."

2. How does Fermilab monitor the external exposure to the embryo/fetus?

10CFR835.402 specifies the requirements for monitoring external and internal occupational dose to a declared pregnant worker. Fermilab must monitor the external occupational dose to a declared pregnant worker who likely to receive a dose equivalent to the embryo/fetus in excess of 10 percent of the applicable limit (50 mrem). This is done using a Dosimetry Badge, that uses Optically Stimulated Luminescent (OSL) technology. Although the embryo/fetus generally only receives a fraction of the dose that the mother receives, Fermilab assumes that the dose to the mother is equal to the dose to the embryo/fetus. In addition, for an instantaneous assessment, pocket dosimeters are often assigned to declared pregnant workers to ensure that the exposures are minimized.

The option is available through the Dosimetry Program Office to establish embryo/fetal monitoring if that is the desire of the declared pregnant worker.

3. If I become pregnant, am I required to inform my employer of my pregnancy?

No. It is your choice whether to declare your pregnancy. If you choose to declare your pregnancy, a lower radiation dose limit will apply to you. If you choose not to declare your pregnancy, you will continue to be subject to the same radiation dose limits that apply to all radiological workers.

4. What happens if I inform my employer in writing of my pregnancy?

The amount of radiation that you will be allowed to received will decrease because both the Nuclear Regulatory Agency and the Department of Energy have a lower dose limit for the embryo/fetus of female workers who have formally declared their pregnancy in writing. Ordinarily, the radiation dose limit for a radiological worker is 5 rem in a year (1500 mrem at Fermilab). The dose limit to the embryo/fetus is 0.5 rem during the 9-month pregnancy. In addition, Fermilab will make efforts to ensure that a substantial variation above a uniform monthly dose rate does not occur. This may mean that, if you declare your pregnancy, you may not be permitted to perform some of your normal job functions and you may not be able to have emergency response responsibilities. If you are a visitor or subcontractor, you may wish to inquire specifically about what would happen in such an instance.

5. Why do the regulations have a lower dose limit for a woman who has declared her pregnancy than for a normal worker?

The purpose of the lower limit is to protect the unborn child. Scientific advisory groups recommend^{1,2} that the dose before birth be limited to about 0.5 rem rather than the 5 rem occupational annual dose limit because of the sensitivity of the embryo/fetus to radiation.

6. What effects on my child's development can be caused by radiation exposure?

Possible effects include deficiencies in the child's development, especially the child's neurological development, and an increase in the likelihood of cancer. The effects of large doses of radiation on human development are quite evident and easily measurable, whereas at low doses the effects can only be inferred.

For example, studies of the effects of radiation on animals and humans demonstrate clearly and conclusively that large doses of radiation -- such as 100 rem -- cause serious developmental defects in many of the body's organs when the radiation is delivered during the period of rapid organ development.^{2,3,4,5}

The developing human brain has been shown to be especially sensitive to radiation. Mental retardation has been observed in the survivors of the atomic bombings in Japan exposed *in utero* during sensitive periods. Additionally, some other groups exposed to radiation *in utero* have shown lower than average intelligence scores and poor performance in school.⁴

The sensitivity of the brain undoubtedly reflects its structural complexity and its long developmental period (and hence long sensitive period). The most sensitive period is during about the 8th to 15th weeks of gestation followed by a substantially less sensitive period for the 2 months after the 15th week. There is no known effect on the child's developing brain during the first two months or the last three months of pregnancy.⁴

No developmental effects caused by radiation have been observed in human groups at doses at or below the 5 rem occupational dose limit. Scientists are uncertain whether there are developmental effects at doses below 5 rem. It may be that the effects are present, but are too small to measure because of the normal variability from one person to the next and because the tools to measure the effects are not sensitive enough. Or, it may be that there is some threshold dose below which there are not developmental effects whatsoever. Recent studies suggest that there is a teratogenic threshold of 30 - 61 rem for mental retardation and one of 150 rad for microcephaly.⁴

7. How much will the likelihood of cancer be increased?

Radiation exposure has been found to increase the likelihood of cancer in many studies of adult human and animal groups. At doses below the occupational dose limit, an increase in cancer incidence has not been proven, but is presumed to exist even if it is too small to be measured.

While the evidence for increased sensitivity of the embryo/fetus to cancer induction from radiation exposure is inconclusive, it is prudent to assume that there is some increased sensitivity. Scientific advisory groups assume that radiation exposure before birth may be 2 or 3 times more likely to cause cancer over a person's lifetime than the same amount of radiation received as an adult.¹ If this is true, there would be 1 radiation-induced cancer death in 2000 people exposed *in utero* at the embryo/fetus limit of 0.5 rem. This would be in addition to the 400 cancer deaths from all causes that one would normally expect in the same group.

8. How does the risk to the embryo/fetus from occupational radiation exposure compare to other risks?

The risk to the embryo/fetus from 0.5 rem or even 5 rem of radiation exposure is relatively small compared to some other risks of pregnancy.

Of particular concern is excessive consumption of alcohol during pregnancy. The U.S. Public Health Service has concluded that heavy alcohol consumption during pregnancy (three drinks or more per day) is the leading known cause of mental retardation (Reference 6). Children whose mothers drank heavily during pregnancy may exhibit developmental problems such as hyperactivity, distractibility, short attention spans, language difficulties, and delayed maturation, even when their intelligence is normal.

In studies tracking the development of children born to light or moderate drinkers, researchers have also correlated their mothers' drinking patterns during pregnancy with low birth weight, decreased attention spans, delayed reaction times, and lower IQ scores at 4 years of age.

There are many other risks associated with pregnancy. Some of these are avoidable; others are not.⁸

9. 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 to occupational radiation at all, but your employer may not have such a position or may not be willing to provide you with a job involving no radiation exposure. Even if you receive no occupational exposure at all, you will typically receive a dose of about 0.3 rem from unavoidable background radiation.⁷

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

Only your employer can tell you what effect a declaration of pregnancy will have on your job status. As part of this packet, you received a copy of Fermilab's policies with respect to the job status of its declared pregnant employees. Visitors and subcontractors are strongly encouraged to speak with their supervisor to learn of the policies that may affect them.

11. What information must I provide to my employer in my declaration of pregnancy?

You must provide 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 gave your letter to your employer. A sample letter of declaration is included with this information. Fermilab employees should direct their letter to the Occupational Medical Director in the Medical Department.

Visitors and subcontractors should direct their memos to their employer. It is requested that the Dosimetry Program Office be copied on such correspondence so that we can most effectively help you to minimize the exposure of your unborn child.

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

For Fermilab employees, the pregnancy does need to be confirmed by Fermilab's Medical Department. Visitors and subcontracts should ask their employer.

13. Can I tell my employer orally rather than in writing that I am pregnant?

No. The declaration must be in writing, for your protection. As far as the regulations are concerned, an oral declaration or statement is the same as not telling your employer that you are pregnant.

14. If I have not declared my pregnancy in writing, but my employer notices 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 for the purpose of minimizing the exposure of your child. The choice of whether to declare your pregnancy is your choice, not your employer's. Your employer may not remove you from a specific job because of the possibility of occupational radiation exposure if you appear pregnant.

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

No. The lower dose limits only apply if you declare that you are already pregnant. However, because many women often do not realize they are pregnant for the first several weeks, it would be prudent to discuss concerns that you have with your Radiation Safety Officer, the Medical Department, or the Dosimetry Program Office. It is always good practice to take steps to minimize your exposure whenever you can.

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

If you have declared your pregnancy in writing, you should promptly inform your employer that you are no longer pregnant. The regulations do not require that the revocation of a declaration be in writing, but we recommend that you revoke the declaration in writing to avoid confusion.

If you have a miscarriage and become pregnant again before you have revoked your original declaration, you should submit a new declaration because the date of conception has changed.

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

The dose to the embryo/fetus must be limited until either your employer knows you have given birth, you inform your employer that you are no longer pregnant, or you inform your employer that you no longer wish to be classified as a declared pregnant worker.

18. If I have declared my pregnancy in writing, can I revoke it even if I am still pregnant?

Yes, you may. The choice is entirely yours. If you revoke your declaration of pregnancy, the lower dose limits no longer apply. Again, this revocation must be made in writing.

19. What steps can I take to lower my radiation dose?

Much of this has already been explained to you as part of the radiological worker training that you have received. If you become pregnant, it is a good time to review the training materials on the methods and procedures that you were provided in your radiological worker training. However, you should ask your supervisor or radiation safety officer whether any additional steps can be taken.

References:

1. National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*, Report No. 1116. Bethesda, MD: 1993.
2. *ICRP Publication 60 -- 1990 Recommendations of the International Commission on Radiological Protection*, Ann. ICRP 21: No. 1-3. Pergamon Press, 1991.
3. *Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V)*, Committee on the Biological Effects of Ionizing Radiations, National Research Council, National Academy Press, Washington, DC, 1990.
4. United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation*, United Nations, New York, 1993.
5. National Council on Radiation Protection and Measurements, *Considerations Regarding the Unintended Radiation Exposure of the Embryo, Fetus or Nursing Child*, NCRP Commentary No. 9, National Council on Radiation Protection and Measurements, Bethesda, MD 1994.
6. *Alcohol, Tobacco and Other Drugs May Harm the Unborn*, U.S. Department of Health and Human Services, Public Health Service, Alcohol, Drug Abuse, and Mental Health Administration, DHHS Publication No. (ADM)92-1711, Rockville, Maryland, 1990.
7. National Council on Radiological Protection and Measurements, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, Report No. 94, Bethesda, MD, 1987.
8. Kane, D. F., E. Sims, L. Stecker, F. Bloe, P. Early and K. O'Brien. *The Declared Pregnant Worker in Nuclear Medicine*. *Journal of Nuclear Medical Technology*. Volume 24, Number 2, pp. 83 - 91. June 1996.

SAMPLE DECLARATION OF PREGNANCY

To: _____

I do hereby voluntarily declare that I am pregnant. My estimated date of conception was _____.

I understand that this means that my occupational radiation dose during my entire pregnancy will not be allowed to exceed 500 mrem (5 millisieverts), unless my occupational radiation exposure has already exceeded this limit upon submittal of this letter.

I also understand that meeting the lower dose limit may require additional restrictions be placed on my work or even a change in job or job responsibilities for the duration of my pregnancy.

It has been explained to me that I may revoke this declaration at any time and that this revocation must be made in writing.

(Your signature)

(Your printed/typed name)

(Date)