



The University of Sheffield

Safety Services



## *Dose Limits and Assessments*

One great difficulty in working with ionising radiations is that one cannot sense their presence, and one can be subjected to a lethal dose of radiation (5Gy to the whole body) and not be aware of it until some time after the event. Early workers found, to their cost, the hazards of working with ionising radiations, and international concern led to the setting up of the International Commission on Radiological Protection (ICRP) in 1928. The Commission has brought together all the information available on the biological effects of ionising radiations, and has then recommended dose limits and good working practices in order to minimise the risks from working with ionising radiations. ICRP recommendations form the basis of all the national regulations.

### **5.1 Biological Effects**

These can be divided into two groups: somatic effects which affect only the person irradiated, and genetic effects where it is the offspring of the person irradiated who is affected, because of damage to germ cells in the reproductive organs. The cells of the body which are most likely to be affected by radiation are those that are dividing, and therefore, those parts of the body where there is a high cell turnover are most sensitive to radiation damage, e.g. blood forming organs, gonads, gut wall, skin. It also follows that growing animals, especially the unborn foetus, are more sensitive to radiation than adults. Therefore, particular consideration is given in setting dose limits for pregnant women and women of reproductive capacity and **it is essential that a female worker informs her Radiation Protection Supervisor as soon as she suspects she is pregnant.**

The ICRP has introduced new terms - stochastic and deterministic (formerly known as non-stochastic) - to describe the effects of ionising radiations. The term stochastic relates to those effects where the probability of the effect occurring is dependent upon the dose received, i.e. the higher the dose received the greater the risk of the effect occurring. The most obvious stochastic effects are the development of cancers. The term deterministic relates to effects which only occur after a certain dose has been received, and where the severity of the effect is directly related to the dose received. Examples of deterministic effects are the development of cataracts (15Gy to the lens of the eye); sterility in men (3Gy to the gonads); and death (5Gy to the whole body).

All the information we have on the effects of radiation is based upon relatively high exposures from people affected by the atom bombs, radiation accidents and animal experiments. Because of the long latent period of most cancers and the fact that cancer is such a common natural cause of death it is virtually impossible to distinguish between radiation induced cancers and natural cancers. One therefore requires a large number of additional cancers induced in order to obtain statistically significant results. Risk estimates have been based upon these high exposures, and it has been assumed that even the smallest dose carries some risk. This may be an over-cautious approach, but it is the basis upon which the dose limits recommended by the ICRP have been set. Some of the current risk factors being used are as follows:-

- Risk of a fatal cancer in the general population - 1:20,000/mSv
- Risk of a fatal cancer in a working population - 1:25,000/mSv
- Risk of severe hereditary disease (general public) - 1:100,000/mSv
- Risk of breast cancer (in women) 1:250,000/mSv
- Risk of skin cancer 1:5,000,000/mSv

## 5.2 Dose Limits

The dose limits recommended by the ICRP, and adopted by our own legislators, are constantly under review as our knowledge of the effects of radiation improves. They are set on the basis that a lifetime's exposure to the maximum dose limits will not result in any deterministic effects, and that the risk of stochastic effects can be kept to an acceptable level for the average exposure of a radiation worker (1 mSv/annum). Exposure up to the dose limits **is not** considered acceptable, and all doses should be kept **AS LOW AS REASONABLY PRACTICABLE**.

### *Dose Limits For Radiation Workers*

Whole body exposure .....	20mSv/annum
Individual organ or tissue or hands .....	500mSv/annum
Lens of the eye .....	150mSv/annum

Special Limits for women-

Abdomen of woman of reproductive capacity .....	13mSv/3 months
Dose constraint for foetus during the term of pregnancy ..	1mSv

**Dose constraint** is a new concept and is not strictly a limit, but a reasonably achievable target to keep below that indicates best practice. There is no reason why, in a University context, that all radiation workers should not keep to within a dose constraint of 1 mSv. This target is reasonably achievable and means that men and

women can generally be treated the same with no undue concern should a woman become pregnant.

It should be noted however that the foetus will preferentially absorb the important body building elements of phosphorous and calcium and any intake by the mother of radioactive isotopes of these elements will lead to significantly higher doses than the mother receives. Further information on this topic can be found in [doses to the foetus](#).

The dose limit for members of the general public from artificial sources has now been set at 1 mSv/annum, except in exceptional circumstances. It is worth noting that the average individual exposure from background radiation is 2.6 mSv/annum. This is predominantly from natural sources (2.2mSv/annum), and can vary considerably depending upon where you live.

### **5.3 Personnel Dose Assessments**

Any person who is likely to receive a dose of radiation in excess of three-tenths of any relevant dose limit is required to be a classified radiation worker and must have his exposure to radiation monitored. Also, any worker who works in a controlled area (see Laboratory Grading Section 8) either has to be classified or work under a written System of Work, and this normally entails personal monitoring. At the University, we go further than these basic requirements, and issue body monitoring devices to all staff who work with penetrating radiations, unless their possible exposure can be shown to be negligible. Work with alpha emitters or weak beta emitters, such as H-3, C-14, S-35, P-33 or Ca-45, does not require the wearing of body badges. It is important that, if you are issued with a body badge, it should be worn at all times whilst working with ionising radiations, and worn correctly (see [personal monitoring](#)). A few people who come into close contact with particularly penetrating radiations will also be requested to wear finger thermoluminescent dosimeters (TLD rings), and they will be given guidance as to their usage at the time. The minimum detectable level of radiation on a body badge is 0.01 mSv for X or gamma radiation and 0.1 mSv for beta radiation and, although the official investigation level for radiation exposures is 15 mSv, here at the University we will be looking into any exposure significantly above the minimum detectable amount, to ensure that all personnel exposure to ionising radiations is kept as low as possible. Our current investigation level has been set at 0.5mSv whole body dose.