

## Radiation Safety and ALARA

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### What is ALARA ?

**ALARA** is an acronym for **As Low As Reasonably Achievable**. This is a radiation safety principle for minimizing radiation doses and releases of radioactive materials by employing all *reasonable methods*. ALARA is not only a sound safety principle, but is a **regulatory requirement** for all radiation safety programs.

### What is the basis for ALARA ?

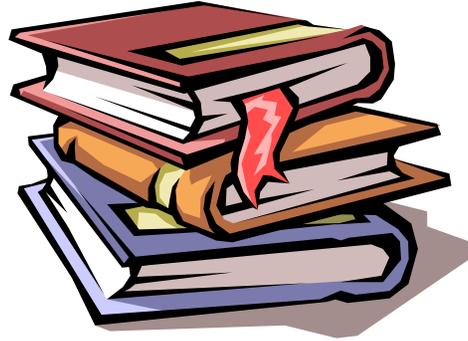
Current radiation safety philosophy is based on the conservative assumption that radiation dose and its biological effects on living tissues are modeled by a relationship known as the “*Linear Hypothesis*”. The assertion is that every radiation dose of any magnitude can produce some level of detrimental effects which may be manifested as an increased risk of genetic mutations and cancer. Thus, the NCSU radiation safety program attempts to lower doses received by radiation workers by utilizing practical, cost effective measures.

### How is ALARA Implemented ?

An effective ALARA program is only possible when a commitment to safety is made by all those involved. This includes the Radiation Safety Division staff, the Radiation Safety Committee, research faculty and all radiation workers. The **NCSU Radiation Safety Manual** provides the guidelines for the responsibilities and good practices which are consistent with both the ALARA concept and the regulatory requirements of the North Carolina Administrative Code (Title 15A Chapter 11). These guidelines and regulations require not only adherence to legal dose limits for regulatory compliance, but also ALARA investigation dose levels which serve as alert points for initiating a review of the work practices of a radiation worker.

### The Radiation Safety Committee and ALARA

The NCSU Radiation Safety Committee (RSC) is an essential element in the successful application of the ALARA concept. The RSC has the responsibility to review



proposed experimental protocols and the qualifications of the Principal Investigator (PI) before authorization is granted for the possession of radioactive materials or radiation-producing devices. The RSC delegates authority to the Radiation Safety Division (RSD) thru the Radiation Safety Officer (RSO) for implementation of the ALARA concept. The RSO is responsible for reviewing the occupational radiation doses of all workers with particular attention to those workers for which the ALARA investigation level is exceeded. The RSC performs an annual review of the radiation safety program in regard to operating procedures and dose records which reflect the efficacy of the ALARA effort.

### The Radiation Safety Division and ALARA

The RSO provides guidance for the ALARA program as the manager and technical supervisor of the Radiation Safety Division. In turn, the RSD staff are responsible for contributing to the success of the ALARA program in the following ways :

- 1) Providing technical support and guidance to the PIs and their staff for implementation of the ALARA concept.
- 2) Performing routine lab inspections to identify possible ALARA issues.
- 3) Monitoring g of worker radiation doses with the assignment of dosimetry and use of bioassays as deemed appropriate.
- 4) Reviewing occupational doses and respond to situations in which the investigation levels are exceeded.
- 5) Providing training and consultation to workers to ensure doses are maintained ALARA.

### PIs, Radiation Workers and ALARA

The PI and research staff, with the support of the RSD, should ensure that the ALARA principle is being used in all lab operations. This includes the proper use of shielding and dosimetry combined with contamination control techniques. All employees bear a responsibility for their own personal safety in such work areas as:

- 1) Awareness of potential radiation hazards, exposure levels and safety controls in their work areas.
- 2) Awareness of operating and emergency procedures.
- 3) Awareness of practices that do not seem to follow the ALARA philosophy.
- 4) Compliance with reporting incidents and possibly unsafe working conditions to their supervisors and, if appropriate, to the RSD staff.
- 5) Compliance with wearing personnel dosimetry and ensuring it's return to the RSD at the proper exchange frequency.
- 6) Compliance with providing bioassay samples to



the RSD as needed.

### Mitigation of External Radiation Exposures

The three (3) major principles to assist with maintaining doses ALARA are :

- 1) **TIME** – minimizing the time of exposure directly reduces radiation dose.
- 2) **DISTANCE** – **doubling** the distance between your body and the radiation source will divide the radiation exposure by a factor of **4**.
- 3) **SHIELDING** - using absorber materials such as Plexiglas for beta particles and lead for X-rays and gamma rays is an effective way to reduce radiation exposures.

## Mitigation of Internal Radiation Exposures

The following practices are effective for reducing potential internal exposures :

- 1) Good hygiene techniques that prohibit the consumption of food and drink in the lab and the control of personal gestures that involve “hand-to-mouth” contacts.
- 2) Frequent swipe surveys and lab area monitoring of work areas, refrigerators, hoods, sinks, phones and computer keyboards, etc.
- 3) Control contamination with absorbent paper and spill trays, properly labeled waste containers, equipment, etc. and prompt decontamination of any detected contamination.
- 4) Use fume hoods for materials which could become airborne (e.g., vapors, dust, aerosols, etc.) and present an inhalation hazard to workers.
- 5) Use proper protective equipment (PPE) such as disposable gloves, safety glasses, lab coats, etc. to reduce the possibility of ingestion or absorption of radioactive materials.

## How are Annual Occupational Dose Limits related to the ALARA concept ?

The annual occupational dose limits have been derived from a study of the observed biological effects of radiation on humans and animals during the 20<sup>th</sup> century. These maximum limits are promulgated on the basis that when applied to occupationally exposed radiation workers they will result in a level of risk no greater than that in other occupations which are deemed to have high safety standards.

### Maximum Annual Occupational Dose Limits

Whole Body .....	5000 millirem
Extremities .....	50000 millirem
Lens of the Eye .....	15000 millirem
Fetus .....	500 millirem*
Individuals in the General Public ...	100 millirem

\* 500 millirem for the fetus is during the *gestation period*

The ALARA concept imposes lower operational dose limits that are even more restrictive than the maximum legal dose limits in the table above. This ensures an enhanced safety factor for what are already considered to be safe annual doses for radiation workers.

## What are the ALARA Investigation Levels ?

### External Radiation Exposures

There are two types of ALARA investigation levels for external occupational radiation exposure as indicated by a dosimeter. If a radiation worker’s dose for any calendar quarter (3 months) or calendar year (12 month period) exceeds these values, an investigation is conducted by the RSO to determine if there are reasonable ways to reduce the dose levels.

#### Quarterly Investigation Levels (3 months)

Based on **2.5 %** of any applicable occupational limit :

#### Annual Investigation Levels ( 12 months)

Based on **10 %** of any applicable occupational limit and is related to an individual worker’s year-to-date cumulative dose.

### What happens if a worker exceeds an



### ALARA investigation dose level?

If a radiation worker’s dosimetry indicates that an investigation level has been exceeded, a notification is sent to the worker and their doses are closely monitored for the remainder of the calendar year. The RSD staff will discuss with the worker methods for limiting the potential dose.

### The Pregnant Worker and ALARA

Licenses are required to attempt to prevent pregnant workers from exceeding ~ 55 millirem during any one month. The desire is to avoid a large dose to the fetus during the 8<sup>th</sup> to the 15<sup>th</sup> weeks of the pregnancy as this is the period during which it is most sensitive to potential radiation-induced effects. Thus, it is incumbent upon the pregnant employee to strongly consider officially notifying the Radiation Safety Division as soon as she is aware of her pregnancy.

