Section 7

ALARA Program

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A. ALARA Principle

ALARA is an acronym formed from the phrase "As Low as Reasonably Achievable." The phrase refers to a principle of keeping radiation doses and releases of radioactive materials to the environment as low as can be achieved, based on technologic and economic considerations.

1. Biological Basis

The biological basis for radiation protection assumes a conservative estimate of radiation dose versus effect, termed the "linear hypothesis." This hypothesis asserts that any dose, no matter how small, may inflict some degree of detriment. This detriment takes the form of a postulated risk of cancer and genetic damage. These risks already exist in the absence of radiation, but could be increased by exposure to ionizing radiation. The University of Washington's Radiation Safety (RS) program, therefore, strives to lower doses. In nearly all situations this can be accomplished, but sometimes this involves more costly practices. Eventually, the costs outweigh the benefit of further dose reduction. ALARA serves as a balance in the University of Washington's radiation protection program.

2. Applied Practices

ALARA principles are commitments to safety by all parties involved in the use of radiation at the University of Washington and include a wide range of easily applied practices. Most of these practices are "common sense". The following paragraphs in this chapter address general ALARA philosophy. However, this entire manual specifically addresses user responsibilities and good practices consistent with both the ALARA program and requirements of the Washington Administrative Code.

3. Operational Dose Limits

A supplementary element to ALARA principles is a set of operational dose limits, called ALARA investigation levels, that should also be readily achievable using easily applied practices. The University of Washington's Radiation Safety program specifies ALARA investigation levels that are well below legal limits.

Investigation levels should not be confused with dose limits that must be strictly adhered to for meeting regulatory compliance. Instead, doses exceeding ALARA investigation levels should alert management, Radiation Safety staff, and radiation users that a review may be needed in an attempt to identify better practices.

4. Collective Dose

In addition to maintaining doses as low as is reasonably achievable for individuals, the sum of the doses received by all exposed individuals (collective dose) should also be at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

B. Radiation Safety Committee Commitment to ALARA

1. Radiation Safety Committee Authority

The Radiation Safety Committee's (RSC) authority is essential to the enforcement of an ALARA program. The RSC or its designees will thoroughly review the qualifications of each applicant for radioactive materials use. This review will take into account the types and quantities of materials used, the user's training and experience, and methods of use for which application has been made. An authorization will only be approved if it seems apparent that the applicant will be able to take appropriate measures to maintain exposure ALARA.

2. Designated Authority

The RSC designates authority to the Radiation Safety Office (RSO) for enforcement of the ALARA concept, and will support the RSO when it is necessary for the RSO to assert authority. The RSO performs a review of occupational radiation exposure with particular attention to instances in which the investigation level is exceeded. The RSO reports this to the Radiation Safety Committee.

3. Annual Review

A formal review of the Radiation Safety program is performed annually by the Radiation Safety Committee (RSC) or their representative. This includes reviews of operating procedures, past dose records, inspections, etc., as well as consultations with Radiation Safety staff and others with a qualified interest in the UW Radiation Safety program. This review is reported to the University of Washington management through the Executive Director of Health Sciences Administration.

C. Radiation Safety Office Commitment to ALARA

1. Radiation Safety Officer

The Radiation Safety Officer enforces the ALARA program through management and technical supervision of Radiation Safety Office staff.

2. Radiation Safety Staff

It is the duty of the RS staff to contribute to the ALARA program through the following areas:

a. Implementation of ALARA Principles

Provide appropriate technical support and guidance to Authorized Investigators and their staff for implementing ALARA principles.

b. Facility Design

Provide input to facility design to comply with regulations and appropriate guidelines.

c. Audits and Surveys

Perform laboratory audits and supplemental RSO laboratory surveys.

d. Monitor Personnel Doses

Provide monitoring of personnel doses through bioassay and assignment of dosimeters when appropriate.

e. Review Occupational Exposures

Review occupational exposures with particular attention to exposures exceeding the ALARA investigation levels. The Radiation Safety Officer reports these instances to the Radiation Safety Committee.

f. Training/Consultation

Provide worker training or consultation.

D. Management Commitment to ALARA

Authorized Investigators and responsible individuals, in consultation with the Radiation Safety Office (RSO), should make sure that ALARA Principles have been considered and incorporated into processes, facilities, and experiments. This could include special monitoring or dosimetry requirements, training, and equipment.

Department managers are also encouraged to review current procedures and develop new ones as appropriate to implement the ALARA concept. These reviews and other routine assessments may suggest the need for modifications to current operating and maintenance procedures, equipment, and facilities. These modifications should be made if they reduce exposures unless the cost is considered to be unjustified (note section I).

E. Employee Responsibility

Employees are responsible for their own safety, specifically in the following areas:

1. Awareness

a. Hazards and Safety Controls

Become familiar with potential radiation-related hazards and safety controls in the areas in which they work.

b. Operating and Emergency Procedures

Become familiar with and follow the operating and emergency procedures pertaining to their assignments.

c. Radiation Levels

Be aware of the radiation levels associated with work assignments.

d. Consult with Supervisors

Consult with supervisors prior to beginning work where whole body or extremity dose could be significantly higher than previously encountered.

e. Inappropriate Practices

Discontinue any practice that does not appear to follow the ALARA principle.

2. Compliance

a. Accident/Incidents

Promptly report radiation accidents, incidents, and unsafe working conditions to supervisors and, if appropriate, also notify the Radiation Safety Office.

b. Dosimeters

Wear a personal radiation dosimeter if one is assigned and exchange it promptly as directed by the Radiation Safety Office.

c. Bioassay

Comply with bioassay requirements.

F. ALARA Principles for Mitigating External Radiation Hazards

The following mitigation methods can often be a practical and effective means of minimizing external radiation hazards. These methods are discussed in greater detail in Section 9 – Radiation Protection Procedures.

1. Time

Reduction of time of exposure can directly reduce radiation exposure.

2. Distance

Increasing the distance between you and the radiation source will reduce exposure by the square of the distance. This principle applies to sources of penetrating radiation (x-rays, gamma rays, or high-energy beta particles). Increasing distance may not be necessary if the radiation is non-penetrating (alpha particles or low energy beta particles).

3. Shielding

Shielding a radiation source often involves additional economic considerations. It is not necessary to shield every source. However, shielding can effectively reduce radiation doses in some situations.

G. ALARA Principles for Mitigating Internal Radiation Hazards

The following general principles are effective for mitigating internal radiation hazards. These are discussed in greater detail in Section 9 – Radiation Protection Procedures.

1. Good Hygiene

Good hygiene habits and good housekeeping effectively moderate the internal radiation hazards presented by radionuclides. Essential elements of good hygiene are eliminating food and drink in areas where radioactive materials are used and/or stored, and controlling “hand to mouth” habits.

2. Control of Contamination

Effective ways to heighten awareness and prevent the spread of contamination is to label radioactive (and potentially radioactive) areas and items, contain contamination, or decontaminate surfaces.

3. Airborne Hazards

Using fume hoods and avoiding dust, aerosol, or volatile gas production can reduce the potential for inhalation of radioactive substances.

4. Protective Clothing

The use of gloves, laboratory coats, and other protective clothing minimizes the chances for the ingestion or absorption of radioactive materials.

H. ALARA Exposure Investigation Levels

1. External Exposure

There are two types of ALARA investigation levels for external occupational radiation exposure as determined by personal dosimeters.

a. Calendar Month

The first is related to the measured dose during any calendar month.

Table 7-1 Monthly Investigation Levels
(10% of the annual limit for occupational radiation exposure)

Dose Quantity	Investigation Level for Exposure During any Calendar Month
Whole Body Deep Dose	500 mrem
Lens of Eye	1500 mrem
Shallow or Extremity Dose	5000 mrem

b. Year-to-Date

The second investigation level is tied to an individual's year-to-date (YTD) cumulative exposure.

Table 7-2 Investigation Levels (mrem) for Year-to-Date Cumulative Exposure

Calendar Quarter	Dates	% of Annual Limit	YTD Deep Dose	Lens of Eye	Shallow or Extremity
1 and 2	Jan. – June	20%	1000	3000	10,000
3	July – Sept.	40%	2000	6000	20,000
4	Oct. – Nov.	60%	3000	9000	30,000

c. Notification/Monitoring

If an individual exceeds the investigation level, a notification letter is sent and their occupational exposures are closely monitored for the remainder of the calendar year. If a pattern of high exposures persists, then RSO staff meets with the individual and/or their supervisor to discuss methods of limiting occupational exposure.

2. Internal Dose

a. Radioiodine

The ALARA investigation level for exposure to radioiodine is 14 nCi, which is equivalent to a dose of 10% of the Annual Limit on Intake (ALI) for I-131, or a Committed Dose Equivalent of 5 rad to the thyroid, assuming 45 days between intake and bioassay date.

b. Tritium

The ALARA investigation level for exposure to tritium (H-3) is 0.015 microcurie/ml in urine. This is approximately equivalent to a dose of 10% of the ALI for H-3, assuming 45 days between intake and bioassay date.

Individual laboratories may choose to perform their own screening bioassays for tritium. However, samples must be submitted for a more rigorous analysis if the urine concentration exceeds 0.001 microcurie/ml (corresponding to less than 1% of the ALI).

I. Cost-Benefit Analysis in ALARA

The International Commission on Radiological Protection (ICRP) has issued a publication titled, "Cost Benefit Analysis in the Optimization of Radiation protection" (1983) – Publication 37. This reference serves as a framework for describing how cost-benefit considerations can play a major role in the decision-making process for optimizing radiation protection.

The basic principle behind cost-benefit methods is to select a protective measure that results in a net benefit that exceeds the next best alternative. The most common method of selecting a protective measure is to assign a dollar cost for a specific dose reduction. The range of costs that have been considered to balance the cost versus risk is normally $200 to $2500 per person-rem reduction in collective dose.

ICRP Publication 37 also gives examples that can be used as guides for evaluating protective measures or systems (such as shielding or ventilation) for particular facilities or experiments under consideration.