UNIVERSITY OF WYOMING

**Radiation Safety Office**
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**Monitoring Criteria for External Radiation**
**Standard Operating Procedure**

I. Introduction

A. Purpose and scope

This document formally describes the criteria used by the Radiation Safety Officer (RSO) to determine when external radiation monitoring devices are issued. The process for measuring internal radiation doses is not included in this document.

B. General Requirements

1. For each radiation worker and member of the general public in radioactive materials areas the Radiation Safety Officer will collect information on the nature and amount of radiation to which the person will most likely be exposed and make these evaluations:

   a. If dosimeters should be issued;

   b. What type(s) will be used and;

   c. The frequency that dosimeters will be exchanged

2. Special considerations will be made for declared pregnant women and persons under the age of 18 years. See section III.

3. Under University policy, personal monitoring is required for (see Radioactive Materials Safety Plan section III.A. and X-ray Safety Plan, section II.A.):

   a. Adult workers likely to receive doses from external sources in excess of ten percent (10%) of their respective limits;

   b. Minors likely to receive an annual deep dose equivalent of 0.1 rem, or 10% of their limits for eye dose or shallow dose to the skin;

   c. Declared pregnant women who are likely to receive a dose of 0.1 rem distributed evenly over the gestation period;

   d. Individuals entering a high or very high radiation area or;

   e. Any other situation deemed appropriate by the RSO.

4. Generally, dosimeters are not required for:

   a. Quantities of radioactive materials handled less than the activities that require labeling (Radioactive Materials Safety Plan III.F.4.);

   b. Pure alpha emitters or;

   c. Emitters of pure beta or photon radiation of such low energy that it cannot be detected by a dosimeter (example H-3, C-14; S-35; Ni-63).

5. The University contracts with a dosimeter service that is accredited under National Voluntary Laboratory Accreditation Program (NVLAP), a voluntary program for determining that a dosimetry service meets American National Standards Institute (ANSI) standards.

C. ALARA and Optional Practice

1. Even if exposures above 10% of the dose limits are unlikely, dosimetry may be issued in order to demonstrate that occupational exposures and exposures to members of the public are kept as low as reasonably achievable (ALARA).

2. Concerned workers (who do not meet the monitoring criteria listed above) may request a temporary dosimeter until such a time that it has been sufficiently demonstrated to them that there is no need for one.

3. Temporary dosimeters are available at RMSO and are available for issue after reasonable notice of a worker's anticipation of meeting the criteria (in section II below). Dosimeters should not be issued to workers who are not currently working near radioactive materials, although they think they may do so in the indefinite future.

D. Definitions

1. Adult Worker. For the purposes of this document, an adult worker is any employee or student of the University of Wyoming or a visiting faculty member (except for minors and declared pregnant women) who is 18 years of age or older and whose assigned duties place them in controlled radioactive materials or X-ray equipment areas.

2. Declared Pregnant Woman. If a female worker becomes pregnant she may notify RMSO in writing of her condition and the estimated date of conception. If she does so, a special evaluation will be made of the radiation hazards of her workplace and the possible resulting hazards to the developing fetus.

3. Dosimetry. The dosimetry devices most commonly used include, but are not necessarily limited to: beta/gamma whole-body badges (brand name Luxel©), thermo-luminescent (TLD) whole-body dosimeters, TLD rings, and beta/gamma/neutron combination whole-body badges.

4. Exchange Period. This is the frequency that the dosimeter is returned to a NVLAP certified vendor to be processed.

5. Minor Worker. Any worker as otherwise defined above who is under the age of 18.

II. Criteria for Dosimetry Issue and Exchange

A. These criteria are subject to re-evaluation by the RSO or the Radiation Safety Committee on a University-wide or case-by-case basis. (See also Tables 1 and 2)

B. Personnel to whom dosimetry shall always be issued

1. Any personnel who meet the requirements of section B.3. above.

a. These personnel will be issued whole-body (film, Luxel or TLD) and/or ring dosimeters, as determined by the RSO. These should be exchanged monthly.

2. Risk Management and Safety personnel whose duties include any of the following: leak-testing and delivery of radioactive materials; handling of radioactive waste materials; leak-testing of radioactive sealed sources; inspections and/or surveys of radioactive usage areas; emergency response involving radioactive materials.

a. These personnel will normally wear whole-body, beta-gamma badges. These dosimeters should be exchanged monthly.

b. The person (usually the RSO) who performs leak-tests on sealed sources may also be issued a ring dosimeter to measure extremity dose. These will be exchanged monthly.

c. Personnel who perform leak tests on, or who handle neutron sources (Am/Be soil moisture density probes, Pu/Be and Cf-252 sources) will be issued a combination beta/gamma/neutron film badge to be exchanged monthly.

C. Alpha Exposure

1. Adult workers will not be issued dosimetry if they work only with pure alpha-emitting isotopes, unless the alpha source is used in conjunction with beryllium to produce neutrons (e.g. Am/Be, Pu/Be sources, see II.G.)

D. Beta Exposure

1. Adult workers will not normally be issued dosimetry if they work only with pure beta-emitting radioisotopes having a maximum energy of less than 250 keV. Examples of these isotopes are: H-3, C-14, P-33, S-35, and Ni-63. These beta energies will not penetrate human skin and do not register exposure using the current dosimeter technology.

2. If radioisotopes emitting maximum beta energies greater than 250 keV will be used (e.g. P-32, Si-32, Sr/Y-90, Ca-45), an evaluation must be made based upon the maximum quantities to be handled:

a. Dosimetry is not required for adult workers handling less than 1 mCi of high-energy beta isotopes at a time. However, dosimetry is recommended in order to demonstrate that exposures are kept as low as reasonably achievable (ALARA). These should be exchanged monthly.

b. Adult workers handling between 1 and 5 mCi at a time should be issued a TLD ring dosimeter. For ALARA purposes, a whole-body badge should also be issued. These should be exchanged monthly.

c. Adult workers handling between 5 and 10 mCi should be issued both a whole body dosimeter and ring dosimeter. These should be exchanged monthly.

d. For adult workers handling more than 10 mCi at a time, a monthly exchange period is mandatory for their ring and whole body dosimeters.

E. Gamma Exposures

1. Adult workers handling low-energy or low-efficiency gamma-emitting radioisotopes (whose exposure rating is less than 0.2 mR/hour per mCi at 1 meter) will be issued dosimeters along the same criteria as high-energy beta users in part 2 of the previous section. Examples of these isotopes would be I-125, and Cr-51.

2. For gamma or X-ray-emitting isotopes with energies higher than those listed above (examples are Na-22 and Se-75):

    a. Adult workers handling 0.5 to 1 mCi at a time should be issued TLD rings. For ALARA, a whole-body dosimeter may also be issued. These should be exchanged monthly.

    b. Adult workers handling more than 1 mCi at a time should be issued a TLD whole body dosimeter, as well as a TLD ring dosimeter. These should be exchanged monthly.

    c. For adult workers handling more than 5 mCi a monthly exchange frequency is mandatory for their ring and whole body dosimeters.

F. X-ray Exposure

1. Personal monitoring devices are required for situations listed in section B.3. The RSO will evaluate each X-ray unit (power, output, shielding, operating procedures, etc.) and take direct radiation measurements to determine personal dosimetry requirements and/or location of area monitors.

2. Open-beam X-ray units include analytical equipment, computed tomography (CT), as well as portable or stationary x-rays used on human or animal subjects.

    a. Generally, operation of open-beam x-rays will require whole-body (i.e. Luxel) dosimeters. Ring TLDs will be used if extremity doses are likely.

    b. In general, Dual Energy X-ray Absorptiometry (DEXA) operators will not be issued dosimetry, unless protocol requires physically manipulating or restraining test subjects (e.g. small animals).

3. X-ray diffraction (XRD) and fluorescence (XRF) equipment should be operated in shielded housings and be equipped with safety interlocks to prevent accidental exposures.

    a. Exposure is unlikely and personnel dosimetry is not required. Area monitors and frequent safety tests by the RSO should be used to identify stray X-ray exposures.

    b. If duties require maintenance or otherwise defeating safety devices, operators will be issued a ring TLD and, if leakage cannot be prevented, a whole-body badge.

4. Electron microscope workers will not normally be issued dosimetry, unless an evaluation by the RSO suggests otherwise.

G. Neutron Exposure

1. Adult workers using neutron-generating devices (e.g. moisture or density probes) and neutron sources (Am-Be, Pu-Be, and Cf-252) will be issued beta/gamma/neutron combination film badges to be exchanged monthly.

III. Special Circumstances

A. Declared Pregnant Women

1. In general, the quantities used which would require dosimetry for declared pregnant women are one-tenth (0.1) the criteria listed in sections II.B and C above. Additional dosimetry may be recommended in order to more accurately monitor exposure to the fetus.

2. If a pregnant woman chooses not to notify RMSO in writing no additional dosimetry evaluation will be made, apart from her normal status as an adult or minor worker.

B. Minors Under the Age of 18

1. Special evaluations will be made for each case where radiation exposure is likely to persons under the age of 18. In general, the quantities used that would require dosimetry for minors are one-tenth (0.1) the criteria listed for adults in sections II.B and C above.

C. Members of the General Public

1. One-time or short-term visitors are not normally issued dosimetry. It is the responsibility of the Principal User in each area to know when visitors will be present, to evaluate potential exposures (or notify the RSO so an evaluation can be made), and to see that the exposure limits for the general public are not exceeded.

2. Items which may be useful in these exposure evaluations are: area monitor records; survey records and/or exposure records of workplace personnel.

D. Other Workers

1. On a case-by-case basis the RSO will evaluate special requests for dosimetry which do not fit within the normal scope of this document.

| TABLE 1. DOSIMETRY CRITERIA AND EXCHANGE FREQUENCY<br>ADULT WORKERS | | | | |
|---|---|---|---|---|
| **Type of Exposure** | **Maximum Activity Handled at One Time** | **Dosimetry Required** | **Dosimetry Recommended** | **Exchange Frequency** |
| Alpha emitters or Beta emitters below 250 keV (H-3, C-14, P-33, S-35) | Any | None | None | None |
| ≥ 250 keV (P-32, Sr/Y-90) *and* Low energy gamma emitters (I-125, Cr-51) | Less than 1 mCi | None | Whole-body badge | Monthly recommended |
| | 1 to 5 mCi | TLD ring | TLD ring and Luxel badge | Monthly recommended |
| | >5 to 10 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Recommended |
| | > 10 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly required |
| Higher energy gamma emitters (Na-22, Se-75) | Less than 0.5 mCi | None | Luxel badge | Monthly Recommended |
| | 0.5 to 1 mCi | TLD ring | TLD ring and Luxel badge | Monthly Recommended |
| | >1 to 5 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Recommended |
| | > 5 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Required |
| Electron microscopes | | None | None | |
| Cabinet X-rays, X-ray Diffraction (XRD), X-ray Fluorescence (XRF) | shielded, with interlocks | None | Area monitor | Monthly |
| | unshielded, leaking | Area monitor | Luxel badge | Monthly |
| | non-existing or bypassed interlocks | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly |
| Open-beam x-ray machines | (except for DEXA) | Luxel badge | TLD ring (manipulations) | Monthly |
| Neutron sources (moisture probes, PuBe, Cf-242 sources) | | Beta/ gamma/ neutron Luxel | TLD ring ( leak testing) | Monthly |

| TABLE 2. DOSIMETRY CRITERIA AND EXCHANGE FREQUENCY MINORS UNDER 18 YEARS AND DECLARED PREGNANT WOMEN | | | | |
|---|---|---|---|---|
| **Type of Exposure** | **Maximum Activity Handled at One Time** | **Dosimetry Required** | **Dosimetry Recommended** | **Exchange Frequency** |
| Alpha emitters or Beta emitters below 250 keV (H-3, C-14, P-33, S-35) | Any | None | None | None |
| > 250 keV (P-32, Sr/Y-90) *and* Low energy gamma emitters (I-125, Cr-51) | Less than 0.1 mCi | None | Whole-body badge | Monthly recommended |
| | 0.1 to 0.5 mCi | TLD ring | TLD ring and Luxel badge | Monthly recommended |
| | >0.5 to 1 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Recommended |
| | > 1 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly required |
| Higher energy gamma emitters (Na-22, Se-75) | Less than 0.05 mCi | None | Luxel badge | Monthly Recommended |
| | 0.05 to 0.1 mCi | TLD ring | TLD ring and Luxel badge | Monthly Recommended |
| | >0.1 to 0.5 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Recommended |
| | > 0.5 mCi | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly Required |
| Electron microscopes | | None | None | |
| Cabinet X-rays, X-ray Diffraction (XRD), X-ray Fluorescence (XRF) | shielded, with interlocks | Area monitor | Luxel badge | Monthly |
| | unshielded, leaking | Luxel badge | Luxel badge | Monthly |
| | non-existing or bypassed interlocks | TLD ring and Luxel badge | TLD ring and Luxel badge | Monthly |
| Open-beam x-ray machines | (except for DEXA) | Luxel badge | TLD ring (manipulations) | Monthly |
| Neutron sources (moisture probes, PuBe, Cf-242 sources) | | Beta/ gamma/ neutron Luxel | TLD ring ( leak testing) | Monthly |