# GENERAL RULES FOR THE SAFE USE OF RADIOACTIVE MATERIALS
## Howard University
## Washington DC

1. Wear laboratory coats or other protective clothing at all time in areas where radioactive materials are used.

2. Wear disposable gloves at all times while handling radioactive materials or waste.

3. Do not eat, drink, smoke, or apply cosmetics in any area where radioactive material is used or stored. Do not store food, drink, or personal effects with radioactive material.

4. Wear personnel monitoring devices (film badges, if applicable) at all times while in areas where radioactive materials are used or stored. These devices should be worn as prescribed by the RSO. Personnel monitoring devices when not being worn to monitor occupational exposures should be stored in a designated low background area.

5. Dispose of radioactive waste only in specially designated and properly shielded and labeled receptacles.

6. Always keep waste and other radioactive material in appropriately shielded containers. Decayed sources are usually kept in their manufacturer's shipping container.

7. Use a cart or wheelchair to move waste and other radioactive material. Always transport material in appropriately shielded containers.

8. Areas and containers in which radioactive materials are stored shall be labeled with a sign indicating, "Caution – Radioactive Materials". The isotope, activity in curies, and date should be written on the sign. Such a sign shall be posted on the door to the appropriately designated storage area.

9. A portable survey meter should be available to personnel handling radioactive material. Personnel authorized to use radioactive material shall be trained in the operation of these instruments.

10. Personnel handling radioactive material should prudently use time, distance and shielding factors:

**TIME:**

Spend as little time as possible handling radio-active material. This will reduce exposure to you and to persons nearby. Mentally preplan your course of actions, such as loading an applicator or suturing I-125 seeds for brain implants, and perform "dry runs" using dummy sources and ribbons before you perform the actual procedure. This will help reduce exposure times. Act quickly but carefully - careless mistakes such as dropping seeds or sources because of rushing will just increase your exposure. Judiciously balance your time and technique.

**DISTANCE:**

Because exposure decreases as the inverse square of the distance from the source, keep as far as practicable from the sources during handling. Always use long- handled forceps when possible. NEVER hold sources with your fingers.

**SHIELDING:**

Use adequate shielding between yourself and the sources when possible. Always keep sources behind the "L shield" when working in the cesium room. Consider the energy of the gamma and/or x-rays emitted from the source when determining the type and thickness of shielding needed to protect you and other staff. Lead aprons are ineffective shields for cesium or iridium sources. Very thin (about 0.1 mm) lead sheet adequately shields I-125 sources. If shielding is not practicable, then reduce your exposure by optimizing the time and distance factors.

Approved by: Satya Ranjan Bose Date: 4/20/2016

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Director of Radiation Safety
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HOWARD UNIVERSITY
Health Sciences

Office of Radiation Safety

## Rules & Responsibilities for Wearing Personnel Monitoring Dosimeters

The privileges of using ionizing radiation require that each individual user strictly adhere to regulations mandated by the regulatory agencies. All individuals who work with radioactive materials or radiation producing devices are required to receive radiation safety training to ensure adherence with regulations. Please remember the following:

- If the personnel dosimeter is lost or damaged, the worker must cease work with radioactive materials/devices producing radiation immediately, until a replacement personnel dosimeter is provided.
- Wear only your own badge while working at Howard University & University Facilities.
- Leave it in a cool, dry place away from radiation when not in use.
- Do not take your badge home.
- Do not launder the badge or get it wet.
- Do not expose to heat, such as in a car in the summer.
- Do not expose the badge to other sources of radiation.
- Do not wear the badge for personal x-ray or nuclear medicine exams.
- Turn in your badge for processing in a timely manner.
- Please cancel badge service when no longer needed.
- The film badge should be worn such that monitoring is optimized (usually on the collar).
- When wearing a lead apron, the badge should be placed on the collar or belt outside the apron. For individuals monitored using two film badges, one should be worn on the collar (outside the apron) and the other should be worn at the waist level under the apron.
- Body badges and finger rings are worn where the highest exposure is expected; rings are worn underneath gloves to avoid contamination. If you are supplied both types, wear both whenever you are working with radiation.
- A missing or invalid dosimeter reading creates a gap in your radiation dose record and affects the monitoring program's ability to provide accurate exposure readings. For a missing dosimeter a "Lost/Damaged Report" must be submitted immediately to his/her supervisor.
- The department supervisor/manager must immediately inform the radiation safety office for replacement. Until a new badge is received, the employee must not be allowed to work with radiation or radioactive materials.

**Please feel free to contact the RSO or Radiation Safety Office with any questions or concerns:**

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## ALARA INVESTIGATION LEVELS

| | Regulatory Limit | Level I | Level II |
|---|---|---|---|
| Whole Body Exposures | 5000 mrem/y | 125 mrem/q | 375 mrem/q |
| Lens of the Eye | 15000 mrem/y | 375 mrem/q | 1125 mrem/q |
| Skin and/or Extremity | 50000 mrem/y | 1250 mrem/q | 3750 mrem/q |
| Minors (whole body) | 100 mrem/y | 10 mrem/q | 30 mrem/q |
| Embryos/Fetus | 500 mrem/9 month gestation | 10 mrem/q | 30 mrem/q |
| Member of Public onsite (EPA) | 100 mrem/y whole body exp. | 5* mrem/q | 15* mrem/q |
| Member of Public offsite (EPA) | 10 mrem/y with less than 3 mrem due to radioiodine from airborne releases | 1* mrem/q | 3* mrem/q |
| Environmental Releases | 10 CFR 20 Appendix B averaged over one year at the unrestricted area boundary. | 10% of 10 CFR 20 Appendix B averaged over the calendar quarter at the boundary; or listed value at the stack. | 30% of 10 CFR 20 Appendix B averaged over the calendar quarter at the boundary; or listed value at the stack. |

- **Personnel dose < ALARA Level I**
  - No further action will be taken if an individual's dose is less than ALARA Level I values.

- **Personnel dose ≥ ALARA Level I but < ALARA II**
  - A timely investigation will be conducted to review the individual's dose history prior to the occurrence of the ALARA Level I dose and monitor the individual's doses for the next 3 months. No response will be necessary unless additional information is requested. Records are documented in ALARA investigation file.

- **Personnel dose ≥ ALARA Level II**
  - The Radiation Safety Officer (RSO) will investigate the causes of exceeding ALARA Level II; consider actions to reduce the probability of occurrence; and present a report on the ALARA Level II occurrences to the Radiation Safety Committee for review.

HOWARD UNIVERSITY

Radiation Safety Office

# Radiation Safety Training

## Introduction

The radiation safety program's primary objectives are to protect personnel and the general public from unwanted radiation exposure, ensure compliance with all applicable US Nuclear Regulatory Commission (NRC) as well as DC Department of Health (DOH) regulations and to monitor and advise the safe use of radioactive materials and radiation producing equipment at the Howard University (HU) and Howard University Hospital (HUH). In order to achieve these goals, the radiation safety office at HU provides radiation safety trainings which includes, but not limited to the following:

- To ensure the use of radioactive material is properly managed.
- To provide for the safety of the user and the environment.
- To be responsive to the needs of the HUH & HUH facilities and the individual user.
- Training personnel in the safe use of radioactive material.
- Administering the personnel monitoring dosimetry.
- To ensure As Low as Reasonably Achievable (ALARA) principle.
- To ensure that operations are in compliance with applicable US Nuclear Regulatory Commission (NRC) as well as DC Department of Health (DOH) regulations.
- Procurement of all radioactive materials.
- Shipment and receipt of all radioactive material.
- Collecting, packaging, and disposing of all radioactive waste.
- Performing routine laboratory inspections.
- Emergency response.
- Providing information and advice to individuals who have questions about radiation.

The HU and HUH are authorized to procure radioactive materials for research and clinical activities. Currently we have the following two NRC licenses:

- Human Use (Clinical) License # 08-03075-07(Limited License)
- Non-human Use (Research & Development) License # 08-00386-19 (Broad License)

The NRC, DC DOH, and HU regulations require that person working with or around ionizing radiation sources must be instructed about the possible hazards of radiation exposure and the procedures to be followed for the safe use of radiation sources. The level of instruction and training is related to the possible hazard. The minimum training requirement for all individuals working with radioactive material or radiation producing equipment, regardless of their past experience and training, is the completion of the initial mandatory training for all new employees (HU & HUH) including annual refresher course.

## Inspection by Regulatory Bodies

The NRC and DOH routinely conduct inspections (separately) at HU & HUH to ensure compliance with applicable federal and State regulations respectively. Violation to DOH, or NRC regulations or license conditions may lead to verdicts (pay money) or revoke the HU & HUH licenses, and the authorization of individual involved. Hence, care must be taken when working with radioactive material and radiation producing equipment for compliance to regulations.

## Sources of Radiation

Radiation is all around you at all times. The average person will receive a dose of 360 mrem each year. About 82% of this, or 295 mrem, arises from natural sources, the largest contributor being terrestrial radiation – including radon – which contributes approximately 228 mrem. About 40 mrem are attributable to natural radiation from the human body itself, while cosmic radiation accounts for about 27 mrem.

Man-made radiation is responsible for the remaining 18%, or 65 mrem, of the average person's annual dose. Of all man-made sources of radiation, medical applications are the largest contributor with an annual dose near 53 mrem. A typical chest or dental X-ray exam, for instance, results in a dose of about 10 mrem. Consumer products, such as tobacco and cosmetics, account for another 10 mrem. The remaining 2 mrem are attributable to fallout, nuclear power, and all other man-made sources of radiation.

## Exposure to Ionizing Radiation

Exposure to ionizing radiation occurs either from radiation sources within work environment (occupational exposures) or from radiation sources outside the work environment (non-occupational exposures).

**Occupational exposures** are radiation exposure received by persons as a result of working with or near radiation sources (radioactive material or radiation producing devices). Occupational exposures are received during 40 hour work per week, hence the need to closely monitor and control radiation exposure to workers at HU & HUH facilities.

**Non-occupational exposures** are received for 168 hour per week from our homes or outside work environment. The means of radiation exposure can be classified into two groups: those from natural sources (e.g. radon, cosmic radiation), and those resulting from man-made sources (from medical procedures such as diagnostic x-ray and nuclear medicine procedures, etc.). The radiation from natural sources is generally called "*natural background radiation*". The background radiation and the related dose vary significantly from one place to another in the United States.

## Routes of Radiation Exposure

There are three exposure pathways by which people are exposed to ionizing radiation, especially when the work involves radioactive materials. They are *external, internal, and contamination*. Each must be carefully evaluated prior to working with radioactive materials or radiation producing machine, and precautions must be taken to prevent these exposures.

### *External Radiation Exposure*

External exposure occurs when radiation from a source external to the body penetrates the body and causes a dose to the body. X-ray machines and gamma emitters of radioisotopes are of greatest concern, followed by beta emitters, and alpha emitters are of least concern. Methods of minimizing external exposure are *time, distance, shielding* and minimizing the amount used.

### *Internal Radiation Exposure*

Radioactive materials may be internally deposited in the body when an uptake occurs through one of the four routes of entry*: inhalation, ingestion, injection, and absorption* (via skin pores or wounds when radioactive material is in contact with skin).

- **Inhalation** occurs when radioactive material is airborne, and a person breathes into the lungs (absorbed by the lungs and deposited in the body). The major concerns are gaseous

radioisotopes (e.g. radon) or radioactively contaminated dust, and smoke. The particles of radioisotope can remain in the lungs for a long time until the decays. Hence, inhalation of radioisotopes that are alpha or beta particle emitters is much concern.

- **Ingestion** occurs when a person swallows food, drink or other consumable items which contain radioactive materials. Radioisotopes may release enormous amounts of energy directly to tissue, resulting damage to DNA and other cell. Alpha and beta emitting radioisotopes are of greatest concern.
- **Absorption** occurs when radioisotope on the *skin surface* is *absorbed* via *skin pores* or *wounds* (cuts or scratches). It is advisable to avoid work with radioactive materials if you have an open wound.
- **Injection** occurs when a person accidentally inject himself/herself with radioisotope during normal job activity.

***Contamination***

Occurs when radioactive material is present on a person (body/skin or clothing), floor, benchtop, equipment or other surfaces. It is either transferable (removable) or non-transferable (fixed). Contamination may lead to internal exposure via absorption process.
*Internal deposition may also result from contaminated hands, with subsequent eating or rubbing of eyes.*

**Radiation Monitoring**

HU & HUH workers radiation exposure are monitored using personnel monitoring film badges and/or rings, and bioassay.

**Personnel Monitoring:** Individual radiation doses are determined from the personnel dosimetry (film badges) obtained from Landauer, Inc. which are issued to anyone working with or frequenting in an area where radioactive materials or radiation producing machines (e.g., x-ray machines) are used. Regulations require issuing film badges to those who are likely to receive at least 10 % of the regulatory dose limits. The Radiation Safety Officer (RSO) decides who will be assigned a badge based on information submitted on the Dosimetry Request Form. Badges are not assigned to anyone working exclusively with electron microscope, and radioisotopes such as H-3, C-14, S-35, Ca-45 and / or P-33, as these radionuclides emit beta particles of energies too low to be detected by the film badge, unless otherwise deemed necessary by the RSO.

**Bioassays:** Bioassays (urinary or fecal samples) are required of anyone performing radioiodinations and anyone using greater than 100 mCi of H-3 at any one time.

**Radiation Dose Limits**

Federal, DOH and HU regulations limit the amount of radiation dose allowed to adult and minor radiation workers, members of the public, and the fetus of a declared pregnant radiation worker.

**Maximum Annual Occupational Dose Equivalent Limits**

| | MREM |
|---|---|
| Whole Body | 5000 |
| Extremities | 50000 |
| Lens of the Eye | 15000 |
| Fetus | 500 |
| Individuals in the General Public | 100 |

| | |
|---|---|
| Hand | 75000 |

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

It is important to note that, for these purposes only, a woman is considered pregnant **ONLY IF SHE DECLARES HERSELF, IN WRITING, TO THE RADIATION SAFETY OFFICER.** A woman may declare or undeclare her pregnancy at any time; it must be in writing to the RSO.

**Typical Medical Doses from Diagnostic Procedures ***

(UNSCEAR, 2000)

| Medical X-ray | MREM |
|---|---|
| Chest Study | 14 |
| Cervical Spine | 27 |
| Pelvis | 83 |
| Skull | 7 |
| Upper GI | 360 |
| Barium Enema | 640 |
| CAT Scan | 880 |

*Effective doses. Doses vary depending on equipment, operator, etc.

**Acute Effects of Radiation***

(Linnemann, 2001)

| Condition | MREM |
|---|---|
| No observable effects | 5000 |
| Blood abnormalities | 15.000 |
| Sperm abnormalities | 15,000 |
| Nausea/ Anorexia | 100,000 |
| Bone marrow depression | 200,000 |
| Epilation | 300,000 |
| Erythema | 600,000 |

*Brief exposure (minutes to a few hours)

**Long term Effects of Radiation[1]**

(UNSCEAR, 2000)

| Effect | MREM |
|---|---|
| Fetal Abnormalities* | 10,000 |
| Cancer* | 10,000 |
| Genetic | 25,000 |
| Cancer Death Risk 5% | 100,000 |
| Genetic Risk .5% | 100,000 |
| Cataracts 10%** | 250,000 |

[1]Brief exposure (minutes to hours)

*Levels below which it becomes exceedingly difficult to consistently demonstrate effects

**10% develop cataracts at this dose (gamma, x-ray)

**Machine Security and Access Restriction**

All the X-ray equipment must be secured from unauthorized removal. Special devices and/or administrative measures must be used to prevent **unauthorized use** of radiation producing machines. Only the authorized technologists are allowed to operate X-ray machines. Mobile X-ray machines must be kept at a secured rooms after use to prevent unauthorized removal. During

exposure, **NO** person other than the operator, ancillary personnel, and patient shall be in the X-ray room or area unless that individual's assistance is required. Mechanical supporting or restraining devices must be used when a patient or image receptor must be held in a position during radiography. If a patient or image receptor must be held by an individual during an exposure, that individual must be protected with appropriate shielding devices and protective equipment. Windows, mirrors, closed circuit television, or provision should be made for the operator to constantly observe the patient during irradiation, as well as able to maintain verbal, visual, and aural contact with the patient.

**Safety Guidelines for Medical X-ray Machine Workers**

All users (operators and other workers) of X-ray equipment must:

1. Receive job specific training, and radiation safety training prior to operating or working with radiation producing equipment.
2. Read, understand and follow all applicable radiation safety rules and emergency procedures before working in and around the radiation producing equipment area.
3. Wear personal radiation monitors if approved by RSO.
4. Wear protective equipment which includes lead aprons, thyroid protectors, protective eye-wear and gloves.
5. Review your own personal dosimetry report and identify unexpected radiation exposures, explore the root cause(s) and implement suitable corrective plan(s) as advised by RSO.
6. Stop the working with X-ray equipment if any unsafe operating conditions arise, and notify your supervisor or department chair or designee of such conditions immediately including the Howard University Radiation Safety Office (RSO).

***If you have any questions regarding any radiation safety related issue, contact the Radiation Safety Officer at 202-373-4161(cell) or (202) 806-7216 (work).***

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