



# Radioactive Materials Safety Manual

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# 1. INTRODUCTION

The intent of the Radiation Safety Committee and the University Administration is to promote a culture of safety and to ensure that all employees and students are provided a safe working and learning environment, free of undue risk. The Radioactive Materials Safety Manual is a written program for the safe use of radioactive materials at Western Kentucky University (WKU).

## 1.1 Purpose

The guidelines contained in this Radioactive Materials Safety Manual have been established by the Radiation Safety Committee to provide for the protection of the University population and the general public against radiation hazards associated with its use of radioactive materials that emit ionizing radiation. This Radioactive Materials Safety Manual also provides for the University's compliance with applicable State and Federal regulations.

## 1.2 Regulatory Basis

### A) Agreement State Status

Section 274 of the Atomic Energy Act of 1954, as amended, provides a statutory basis under which the U.S. Nuclear Regulatory Committee (NRC) relinquishes to the States portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. The mechanism for the transfer of NRC's authority to a State is an agreement signed by the Governor of the State and the Chairman of the Commission, in accordance with section 274b of the Atomic Energy Act.

On March 26, 1962, the Commonwealth of Kentucky became the first Agreement State.

### B) Commonwealth of Kentucky, Department for Public Health, Cabinet for Health and Family Services, Radiation Health Branch

The mission of the Radiation Health Branch is to:

1. Ensure the beneficial use of radiation; and
2. Protect the public from unnecessary exposure to the harmful effects of radiation.

The Commonwealth of Kentucky is an NRC Agreement State. This means the NRC has relinquished regulatory control for oversight of all Atomic Energy Act (AEA) activities in Kentucky except for federal facilities and certain quantities of special nuclear material.

Kentucky also utilizes the Conference of Radiation Control Program Directors' suggested state regulations. These regulations provide uniformity on a national level.

The Radiation Health Program is responsible for licensure, registration, and certification of all uses of radiation. The program conducts inspections, reviews and validates environmental surveillance data, and manages compliance activities. The Program is responsible for statewide emergency response to radiological incidents and emergencies and is equipped to respond to radiological emergencies 24 hours a day (Kentucky Emergency Management Duty Office 800-255-2587)

#### C) Radioactive Material License

The use of radioactive materials at WKU is conducted under the authority of its specific license issued by the Kentucky Cabinet for Health & Family Services (CHFS).

The license covers all licensed radioactive materials use for the entire university. Any individual or action that jeopardizes the license endangers the permission of all authorized individuals who use radioactive materials at WKU. Therefore, this license places significant responsibility on individuals who use radioactive materials to conform to safe work practices, and to conduct and complete all required license activities in the course of their use of radioactive materials.

#### D) Regulations

The use, storage, transportation, and disposal of radioactive material must conform with the applicable regulations of the Cabinet for Health and Family Services of the Commonwealth of Kentucky, as well as all other pertinent federal and state regulations, the conditions of WKU's license, and the conditions set forth in the Authorized User's Radiation Work Permit (RWP).

Regulations pertaining to the use of radioactive materials are found in the Kentucky Administrative Regulations (KAR) Title 902 Chapter 100. Copies of the most current regulations can be viewed at <https://apps.legislature.ky.gov/law/kar/TITLE902.HTM> .

The University is subject to Kentucky Administrative Regulations (KAR). These regulations are the basis of the WKU Radioactive Materials Safety Manual. Not all requirements specified in the regulations are restated in this manual. The manual is meant to summarize the KAR requirements and indicate additional requirements determined by the Radiation Safety Officer and the Radiation Safety Committee.

#### E) Notice to Employees

Kentucky regulations require that the "Notice to Employees" posting is available to radiation workers. This posting is displayed in all radioactive materials areas throughout the university. This notice provides information regarding the responsibilities of both the radiation worker and the employer.

#### F) Reporting Concerns and Suspected Violations

If you believe that a violation of KY's regulations or the WKU's license has occurred, report the violation to the Authorized User supervising the work or area involved. If you believe that adequate corrective action has not been taken, notify the RSO at (270) 745-3597. You also have the right to contact the KY Radiation Health Branch at (502) 564-3700.

#### G) Access to Information

State regulations require WKU to provide workers access to certain notices, instructions, and reports, and the options available to individuals regarding safety concerns and suspected violations.

Faculty, staff, and students at WKU may examine copies of the following documents at the Department of Environmental Health and Safety office located at 1716 Park Street, Bowling Green, or by contacting the RSO at 270-745-3597.

- CHFS regulations and inspection reports for radioactive materials
- The WKU Radioactive Material License
- Individual dosimetry reports (dosimetry reports will only be shown to the individual for whom the report belongs unless written authorization is provided by that individual).

#### H) Internal Audits

##### 1. Annual Audits

Annual audits shall be conducted for each radioactive materials use area by the RSO or a suitable individual designated by the RSO. The audit format will generally be that format specified in KY Radiation Health Branch licensing guides. However, the audit formats may be modified as necessary to address unique aspects of a given use area.

##### 2. Notices of Violation

In addition to the annual audits, Radiation Safety Violation Reports will be issued by the RSO if deficiencies are noted at times between the formal annual audits. These reports will be issued for deficiencies as simple as outdated license postings or improper survey documentation up through violations that pose a threat to health and safety. Identified violations will be reported to the KY Radiation Health Branch when the violation is required by 902 KAR 100 to be reported.

### 1.3 Scope

The Radiation Safety Officer & Committee's radiation guidelines apply to all departments, laboratories, and persons at WKU that receive, possess, use, transport, or dispose of radioactive material and/or equipment.

The WKU Radioactive Materials Safety Manual applies to all employees and students engaged in the storage, use and transport of radioactive materials. This Manual describes necessary protection from risks posed by radioactive materials. All WKU entities must comply with the requirements detailed in this document. This plan does not specifically address protection needed against chemical, biological, or other hazards (i.e. electrical, laser, mechanical, etc.), and defers to other policies and committees to oversee those safety topics and concerns.

The WKU Radiation Producing Machines Safety Manual details practices and regulations WKU adheres to in order to ensure the safe operation of radiation producing machines.

The purpose of the Laboratory Safety and Chemical Hygiene Plan is to describe practices and procedures pertaining to working with or around any hazardous materials or chemicals within a university laboratory or classroom setting. This plan is to provide guidance for safe handling of all hazardous chemicals in laboratories; as well as to ensure compliance with Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), and local applicable regulations.

The Laser Safety Program is designed to ensure that no laser radiation in excess of the maximum permissible exposure limit reaches the human eye or skin and encompasses all laser users at WKU.

WKU activities, both research and educational, involving recombinant DNA, culturing of microorganisms, agents infectious to plants, humans, and animals, human gene therapy, cultures of tissues, organs, and cells of human origin, and Select Agents as defined by U.S. federal agencies are governed by WKU's Institutional Biosafety Committee (IBC).

Similarly, the Institutional Animal Care and Use Committee (IACUC) oversees all research, research training, experimentation, biological testing, and related activities involving live, vertebrate animals supported by the Public Health Service (PHS) and conducted at WKU, or at another institution as a consequence of the sub-granting or subcontracting of a PHS-conducted or supported activity by this institution.

## 2. ABBREVIATIONS AND DEFINITIONS

For the purposes of this Radioactive Materials Safety Manual, the following abbreviations and definitions will be used.

**ALARA:** As Low As Reasonably Achievable

**AU:** Authorized User

**Bq:** becquerel

**C:** coulomb

**Cabinet:** Kentucky Cabinet for Health and Family Services

**CEDE:** committed effective dose equivalent

**CFR:** Code of Federal Regulations

**CHFS:** Kentucky Cabinet for Health and Family Services

**Ci:** curie

**μCi:** microcurie

**mCi:** millicurie

**cm<sup>2</sup>:** square centimeter

**DDE:** deep dose equivalent

**DOE:** United States Department of Energy

**DOT:** United States Department of Transportation

**dps:** disintegrations per second

**dpm:** disintegrations per minute

**EH&S:** WKU Department of Environmental Health & Safety

**gal:** gallon

**GM or G-M:** Geiger-Mueller

**Gy:** gray

**hr:** hour

**J:** Joule

**KAR:** Kentucky Administrative Regulations

**kg:** kilogram

**LDE:** lens dose equivalent

**LD<sub>50</sub>:** lethal dose, 50 %

**LET:** linear energy transfer

**LLRW:** Low Level Radioactive Waste

**LLRMW:** Low Level Radioactive Mixed Waste

**LSA:** liquid scintillation analyzer

**MeV:** mega electron volt

**ml:** milliliter

**mR:** milliroentgens

**mrem:** millirem

**NORM:** Naturally Occurring Radioactive Material

**NRC:** United States Nuclear Regulatory Commission

**OSL:** optically stimulated luminescence

**PPE:** personal protective equipment

**Q:** quality factor

**R:** roentgen

**rad:** radiation absorbed dose

**RHB:** Kentucky Radiation Health Branch

**RMSM:** Radioactive Material Safety Manual

**RSC:** Radiation Safety Committee

**RSO:** Radiation Safety Officer

**RBE:** relative biological equivalent

**rem:** roentgen equivalent man

**RWP:** Radiation Work Permit

**SDE:** shallow dose equivalent

**SI:** standard international

**SU:** Supervised User

**Sv:** sievert

**TEDE:** total effective dose equivalent

**TLD:** thermoluminescent dosimeter

**t<sub>1/2</sub>:** half life

**WKU:** Western Kentucky University

**XRF:** x-ray fluorescence

*Absorbed Dose* – The amount of ionizing radiation energy absorbed in matter per unit mass, including human tissue. The units of absorbed dose are the rad and the gray (Gy). 1 rad = 0.01 Gy

*Activation* – The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear radiation.

*Activity* – The rate of transformation (or “disintegration” or “decay”) of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq). 1 Ci =  $3.7 \times 10^{10}$  Bq

*Acute Exposure* – The absorption of a relatively large amount of radiation (or intake of radioactive material) over a short period of time.

*Acute Health Effects* – Prompt radiation effects (those that would be observable within a short period of time) for which the severity of the effect varies with the dose, and for which a practical threshold exists.

*Acute Radiation Syndrome* – The complex of symptoms characterizing the disease known as radiation injury, resulting from excessive exposure of the whole body (or large part) to ionizing radiation. The earliest of these symptoms are nausea, fatigue, vomiting, and diarrhea, which may be followed by loss of hair (epilation), hemorrhage, inflammation of the mouth and throat, and general loss of energy. In severe cases, where the radiation exposure has been relatively large, death may occur within two to four weeks. Those who survive six weeks after the receipt of a single large dose of radiation may generally be expected to recover.

*Agreement State* – Any State with which the U.S. Nuclear Regulatory Commission or the U. S. Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended (73 Stat. 689).

*ALARA* – (Acronym for “as low as is reasonably achievable”)--Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and radioactive materials in the public interest.

*Alpha Particle* – A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2.

*Annual Limit on Intake (ALI)* – The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rem or a committed dose equivalent of 50 rem to any individual organ or tissue.

*Background radiation* – Radiation that occurs naturally in the environment. Background radiation consists of cosmic radiation from outer space, radiation from the radioactive elements in rocks, soil, and foods, and radiation from radon and its decay products in the air we breathe.

*Becquerel* – A unit, in the International System of Units (SI), of measurement of radioactivity equal to one disintegration per second.

*Beta Particle* – A negatively charged particle that is emitted by certain radioactive atoms. A beta particle is identical to the electron.

*Bioassay* – The determination of kinds, quantities or concentrations and in some cases, the locations, of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed (in vitro) from the human body.

*Biological half-life* – The time required for a biological system, such as that of a human, to eliminate by natural processes half of the amount of a substance (such as a radioactive material) that has entered it.

*Chronic dose* – The absorption of radiation (or intake of radioactive materials over a long period of time, i.e., over a lifetime).

*Class (or Lung Class or Inhalation Class)* – A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times; for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

*Committed dose equivalent ( $H_{T,50}$ )* – The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the fifty (50) year period following the intake.

*Committed effective dose equivalent ( $H_{E,50}$ )* – The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ( $H_{E,50} = \sum W_T H_{T,50}$ ).

*Contamination* – the deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

*Cosmic radiation* – Penetrating ionizing radiation, both particulate and electromagnetic, originating in space. Secondary cosmic rays, formed by interactions in the earth's atmosphere, account for about 45 to 50 millirem annually.

*Cumulative dose* – The total dose resulting from repeated exposures of ionizing radiation to the same region, or to the whole body, over a period of time.

*Curie (Ci)* – The basic unit of activity. One curie of a radionuclide undergoes an average disintegration rate of 37 billion disintegrations per second, the approximate activity of one gram of radium. Named for Marie and Pierre Curie, who discovered radium in 1898.

*Daughter product* – The nuclide produced by the decay of a radioactive nuclide

*Declared pregnant woman* – A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

*Deep dose equivalent* – The dose equivalent estimated for a tissue depth of 1 cm. The deep-dose equivalent applies to external whole-body exposure and is intended to represent the upper limit to the dose received by the major organs and tissues of the body other than skin and lens of the eye.

*Detector* – A material or device that is sensitive to radiation and can produce a response signal suitable for measurement or analysis. A radiation detection instrument.

*Dose (or radiation dose)* – A generic term that means absorbed dose, equivalent dose, effective dose, committed equivalent dose, committed effective dose, or total effective dose, as defined elsewhere in this section.

*Dose equivalent ( $H_T$ )* means the product of the absorbed dose in tissue, the quality factor, and other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

*Dose rate* – The radiation dose delivered per unit time. Measured, for example, in rem or Sv per hour.

*Dosimeter* – A portable instrument for measuring and recording the total accumulated exposure to ionizing radiation.

*Effective dose equivalent ( $H_E$ )* – The sum of the products of the dose equivalent to the organ or tissue ( $H_T$ ) and the weighting factors ( $W_T$ ) applicable to each of the body organs or tissues that are irradiated ( $H_E = W_T H_T$ ).

*Effective half-life* – The time required for the amount of a radioactive element deposited in a living organism to be diminished 50 percent as a result of radioactive decay and biological elimination.

*Electromagnetic radiation* – Energy being propagated by a traveling wave motion resulting from changing electric or magnetic fields. Familiar electromagnetic radiations range from x-rays and gamma rays of short wavelength, through the ultraviolet, visible and infrared regions, to radar, and radio waves of relatively long wavelength. The ionizing electromagnetic radiations are gamma rays and x-rays.

*Exposure* – A measure of the ionization produced in air by x- or gamma radiation; the sum of electric charges on all ions of one sign produced in air when all electrons liberated by photons in a volume of air are completely stopped in air, divided by the mass of the air in the volume; unit of exposure in air is the roentgen. Also, being exposed to ionizing radiation or to radioactive material.

*External Dose* – That portion of the dose equivalent received from radiation sources outside the body.

*Gamma Rays* – Gamma radiation is high-energy, short-wavelength electromagnetic radiation typically emitted from the nucleus. A gamma ray is a discrete packet of electromagnetic energy. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead. Gamma rays are similar to x-rays but have a nuclear origin, rather than an atomic origin, and smaller wavelength.

*Gray (Gy)* – The SI unit of absorbed dose. One gray is equal to an absorbed dose of  $1 \text{ J kg}^{-1}$  (100 rad).

*Half-life* – The time in which one half of the atoms of a particular radioactive substance disintegrate into another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

*Ion* – An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus.

*Ionization* – The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiations can cause ionization.

*Ionizing Radiation* – Any radiation capable of producing ions by displacing electrons from atoms or molecules. Some examples are alpha, beta, gamma and x-rays, and neutrons.

*Isotope* – One of two or more types of atoms with the same number of protons, but different numbers of neutrons in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the number denoting the approximate atomic weights. Isotopes of a given element are chemically identical, but differ slightly in mass and often have different physical or radioactive properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

*Lens dose equivalent* – The dose equivalent, upon external exposure of the lens of the eye, at a tissue depth of 0.3 centimeter (300 mg/cm<sup>2</sup>).

*Lethal dose* – The dose of radiation expected to cause death in an exposed population. Lethal dose is often expressed as lethal dose X/Y (abbreviated LD X/Y), where X is the percentage of the population expected to die from the given dose after Y days. For example, lethal dose 50/60 means that 50% of the population is expected to die in 60 days. Typically, the LD 50/60 is generally accepted as 500 rad (5 Gy) received over a short period of time.

*Low toxicity alpha emitter* – Natural uranium, depleted uranium, natural thorium, uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than ten (10) days.

*Mixed waste* – Radioactive waste that also meets the US EPA definition of being chemically hazardous.

*Neutron* – An uncharged particle with a mass comparable to (only slightly greater than) that of the proton, and found in the nucleus of every atom heavier than hydrogen.

*Nuclide* – A general term referring to any known isotope, either stable or unstable, of any chemical element. A radionuclide refers to an unstable, radioactive isotope. Approximately 2500 natural and artificial radionuclides (radioisotopes) have been identified.

*Occupational radiation exposure* – The radiation exposure or dose to an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive materials. Occupational dose does not include dose received from: background radiation, as a patient from medical practices; from voluntary participation in medical research programs; or as a member of the general public.

*Parent* – A radionuclide that upon radioactive decay or disintegration yields a different nuclide (the daughter).

*Personnel monitoring* – The continuous measurement of an individual's exposure to external radiation by means of suitable devices, such as film badges, TLD or OSL badges, pocket dosimeters, or electronic dosimeters, worn on the individual's person.

*Quality factor* – A numerical factor assigned to describe the average effectiveness of a particular kind (and sometimes energy) of radiation in producing biological effects in the human. The factor used to derive equivalent dose from absorbed dose.

QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES		
Types of Radiation	Quality Factor (Q)	Absorbed Dose Equal to a Unit Dose Equivalent <sup>a</sup>
X-, gamma, or beta radiation	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown energy	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

<sup>a</sup> Absorbed dose in rad equal to one rem or the absorbed dose in gray equal to one sievert. If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in rems per hour or sieverts per hour, one rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of the rules in 15A NCAC 11, be assumed to result from a total fluence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee or registrant may use the fluence rate per unit dose equivalent or the appropriate Q value from the following table to convert a measured tissue dose in rads to dose equivalent in rem.

MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT DOSE EQUIVALENT FOR MONOENERGETIC NEUTRONS		
Neutron Energy (MeV)	Quality Factor <sup>a</sup> (Q)	Fluence per Unit Dose Equivalent <sup>b</sup> (neutrons cm <sup>-2</sup> rem <sup>-1</sup> )
2.5 x 10 <sup>-8</sup> (thermal)	2	980 x 10 <sup>6</sup>
1 x 10 <sup>-7</sup>	2	980 x 10 <sup>6</sup>
1 x 10 <sup>-6</sup>	2	810 x 10 <sup>6</sup>
1 x 10 <sup>-5</sup>	2	810 x 10 <sup>6</sup>
1 x 10 <sup>-4</sup>	2	840 x 10 <sup>6</sup>
1 x 10 <sup>-3</sup>	2	980 x 10 <sup>6</sup>
1 x 10 <sup>-2</sup>	2.5	1010 x 10 <sup>6</sup>
1 x 10 <sup>-1</sup>	7.5	170 x 10 <sup>6</sup>
5 x 10 <sup>-1</sup>	11	39 x 10 <sup>6</sup>
1	11	27 x 10 <sup>6</sup>
2.5	9	29 x 10 <sup>6</sup>
5	8	23 x 10 <sup>6</sup>
7	7	24 x 10 <sup>6</sup>

10	6.5	$24 \times 10^6$
14	7.5	$17 \times 10^6$
20	8	$16 \times 10^6$
40	7	$14 \times 10^6$
60	5.5	$16 \times 10^6$
$1 \times 10^2$	4	$20 \times 10^6$
$2 \times 10^2$	3.5	$19 \times 10^6$
$3 \times 10^2$	3.5	$16 \times 10^6$
$4 \times 10^2$	3.5	$14 \times 10^6$
<sup>a</sup> Value of quality factor (Q) at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.		
<sup>b</sup> Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue-equivalent phantom.		

**Rad** – The special unit of absorbed dose. One rad is equal to an absorbed dose of  $0.01 \text{ J kg}^{-1}$  (0.01 gray).

**Radiation (ionizing radiation)** – Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this manual, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

**Radioactivity** – The process of undergoing spontaneous transformation of the nucleus, generally with the emission of alpha or beta particles, often accompanied by gamma rays. The term is also used to designate radioactive materials.

**Radioactive Material** – Radioactive material is any material that contains radioactive atoms.

**Radioactive Contamination** – Deposition of radioactive material in any place where it may harm persons or equipment.

**Radiation sickness (syndrome)** – The complex of symptoms characterizing the disease known as radiation injury, resulting from excessive exposure of ionizing radiation (greater than 200 rads or 2 gray) of the whole body or a large area. The earliest of these symptoms are nausea, fatigue, vomiting, and diarrhea, which may be followed by loss of hair (epilation), hemorrhage, inflammation of the mouth and throat, and general loss of energy. In severe cases, where the radiation exposure has been approximately 1,000 rad (10 gray) or more, death may occur within two to four weeks. Those who survive six weeks after a single large dose of radiation may generally be expected to recover.

**Rem** – The special unit of any of the quantities expresses as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert).

*Roentgen (r)* – A unit of exposure to ionizing radiation. It is that amount of gamma or x-rays required to produce ions carrying 1 electrostatic unit of electrical charge in 1 cubic centimeter of dry air under standard conditions. Named after Wilhelm Roentgen, German scientist who discovered x-rays in 1895.

*Shallow-dose equivalent ( $H_s$ )* – With respect to external exposure of the skin or an extremity, means the dose equivalent at a tissue depth of 0.007 centimeter (seven (7) mg/cm<sup>2</sup>) averaged over an area of one (1) square centimeter.

*Sievert* – The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

*State* – The Commonwealth of Kentucky.

*Total effective dose equivalent (TEDE)* - The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

*Waste, radioactive* – Solid, liquid, and gaseous materials from nuclear operations which are radioactive or become radioactive and for which there is no further use. Wastes are generally classified as high-level (having radioactivity concentrations of hundreds of thousands of curies per gallon or cubic foot), low-level (in the range of 1 microcurie per gallon or cubic foot), or intermediate level (between these extremes) (see 10 CFR Parts 60 and 61).

*Whole body* – For purposes of external exposure, whole body means the head, trunk (including male gonads), arms above the elbow, or legs above the knee.

*Wipe test* – A method of determining the removable contamination on a surface. The suspected area is wiped with a filter paper, cotton swab, or similar medium and the radioactivity on the wipe media is measured.

*X rays* – Penetrating electromagnetic radiation having a wavelength that is much shorter than that of visible light. Rays produced by excitation of the electron field around certain nuclei are called characteristic x-rays. Electromagnetic rays that are produced as the result of deceleration of charged particles as they pass near the nucleus are called continuous x-rays (or Bremsstrahlung). X-rays are identical to gamma rays, but originate outside the nucleus.

#### References

902 KAR 100:010. Definitions for 902 KAR Chapter 100.

Bernard Shleien, Lester A. Slaback, Jr., and Brian Kent Birky, eds. Handbook of Health Physics and Radiological Health. 3rd ed. Lippincott Williams & Wilkins, 1998.

### **3. AUTHORITY, ROLES, AND RESPONSIBILITIES**

Western Kentucky University supports the use of radioactive materials and other potentially hazardous materials for the purposes of education and research. WKU is committed to ensuring the safety and longevity of its students, employees, and visitors in addition to complying with all regulatory requirements that impact its facilities and operations relating to environment, health and safety. WKU administration, faculty, staff, and students are asked to support this goal in all university activities.

Employees and students are encouraged to raise safety concerns to University Administration, members of the Radiation Safety Committee, the Radiation Safety Officer, or the Radiation Health Branch of the Kentucky Cabinet for Health & Family Services without fear of retaliation. Formal complaints should be in writing, delivered to any member of the Radiation Safety Committee, the Radiation Safety Officer, the General Counsel, or the Radiation Health Branch of the Kentucky Cabinet for Health & Family Services.

The following outlines specific responsibilities associated with radioactive materials. All parties identified in this plan must cooperate to ensure that academic and research activities are conducted safely to protect workers, students, the community and the environment. These guidelines apply to all departments, laboratories, and persons at WKU that receive, possess, use, transport, or dispose of radioactive material and/or equipment.

### **3.1 Radiation Safety Committee**

Western Kentucky University (WKU) Radiation Safety Committee (RSC) has the authority and responsibility delegated from the President of WKU for developing and maintaining a radiation safety program for the University to ensure the safe handling of radioactive materials in the University's instructional, research, and operational programs.

Among its duties, it shall recommend University policy with respect to radiation safety; establish standards and regulations for radiation safety at all University-controlled facilities; review and record safety evaluations of all activities involving ionizing radiation at University-controlled facilities and authorize those found to be acceptable; review annually the operations and procedures of Radiation Safety; and act as the statutory radiation safety committee required by the University's state and federal licenses pertaining to radioactive materials and radiation generators.

The bylaws of the Radiation Safety Committee are located in [Appendix A](#) of this manual. The Radiation Safety Committee delegates the responsibility of approving users and uses of radiation producing machines covered by this manual to the Radiation Safety Officer.

#### **A) Responsibilities**

1. To establish and continually review the radiation protection program at WKU so as to maintain human radiation exposures and radioactive effluent at levels which are As Low As Reasonable Achievable (ALARA) and always below the maximum levels as set forth by Kentucky (KY) and Federal Agencies.
2. To ensure WKU's compliance with radiation protection regulations promulgated by KY and Federal Agencies and with terms dictated by WKU's Radioactive Material License.
3. To annually review the training of WKU personnel in the proper use of radioisotopes and guidelines in activities related to radioisotopes.
4. To annually review the entire radiation protection program in accordance with documentation of discussion maintained in the minutes.
5. To broadly educate the WKU community on the importance of radiation safety and the culture of safe progress.

## B) Authority

To meet these responsibilities, the RSC has been given the following authority:

1. To grant, deny, or suspend authorization to use radioactive material and/or equipment that emits ionizing radiation, by WKU personnel, while on WKU property.
2. To apply restrictions on the amount of occupational radiation exposure that any individual WKU personnel may receive during his/her association with WKU upon the recommendation of the Radiation Safety Officer.
3. To establish and follow specific administrative guidelines for approval of the uses of radioactive material or equipment containing radioactive material.

## 3.2 Radiation Safety Officer

Radiation Safety Officer (RSO) is to provide technical guidance for the continued implementation of the Radioactive Materials Safety Manual. The RSO is appointed by the President of WKU. Management shall provide sufficient time for the RSO to perform his/her duties and responsibilities.

### A) Responsibilities

1. To ensure that radioactive material possessed or used by the applicant is limited to those materials specified in the license.
2. To ensure that the radioactive materials/devices are used only by those individuals, or under the supervision of individuals, authorized by the license.
3. To ensure that all users wear personal monitoring equipment (if required) such as film badges, optically stimulated luminescence (OSL) dosimeters, thermoluminescent dosimeters (TLD's), and/or pocket dosimeters.
4. To ensure that all reports of personnel exposure are reviewed in a timely manner.
5. To ensure that licensed material/gauges are properly secured against unauthorized removal at all times, when not in use.
6. To develop operating and emergency guidelines and to assist in personnel training and orientation in these guidelines.
7. To serve as a point of contact and give assistance in case of emergency and to ensure that proper authorities are notified promptly in case of an accident involving radioactive material/devices or other incidents that may involve the release of radioactive material (e.g. structural damage, fire, or theft).
8. To ensure that the terms and conditions of the license such as periodic leak tests are met and that the required records such as personnel exposure, leak tests, receipt, transfer, disposal, etc., are periodically reviewed for compliance with Cabinet regulations and the license conditions.
9. To provide oversight of radiation safety at all WKU use/storage locations.
10. To ensure that radioactive material is transported in accordance with all applicable DOT requirements.
11. To ensure that radioactive material is disposed of properly.
12. To report to the RSC any violations of established radiation safety guidelines, violations against the license, or violations against 902 KAR 100.

13. To maintain records and submit reports as required by KY and Federal Agencies.
14. To conduct internal audits at least annually to include radioisotope laboratory inspections, radiation surveys, and area monitoring. These audits shall (1) determine compliance with Cabinet and DOT regulations and the terms and conditions of the license, (2) evaluate the effectiveness of the radiation protection program content and implementation, and (3) ensure that required records are properly maintained.
15. To document (and maintain) audit results, identification of deficiencies, and recommendations for change, and to provide this information to the RSC.
16. To ensure that audit results and corrective actions are communicated to all personnel who use radioactive material/devices (regardless of their location or the license under which they normally work).
17. To have up-to-date copies of regulations 902 KAR 100, review new or amended regulations, and review license guidelines, as needed to comply with Cabinet regulations.
18. To ensure that all incidents, accidents, and personnel exposure to radiation in excess of ALARA or 902 KAR 100:019 limits are investigated and reported to the Cabinet and other authorities, as appropriate, within required time limits.
19. To ensure the license is amended whenever there are changes in: licensed activities or information or commitments provided to the Cabinet in the licensing process.

#### B) Authority

1. To terminate any activity employing radiation that is a threat to health or property after notification of the person in charge. (The RSC has final disposition of any disputes.)
2. To make recommendations to the RSC on granting, denying, or suspending the authorization to use radioactive materials and/or equipment that emits ionizing radiation, by WKU personnel, while on WKU property.
3. To recommend or order remedial action to correct safety deficiencies.
4. To approve/deny procuring, receiving, and shipping all WKU radioactive material. This decision shall be made, in writing, prior to any transactions occurring.
5. To give provisional or emergency approval for the transfer or use of radioactive materials.
6. To designate a member of the RSC to act when the RSO is absent from WKU.

### 3.3 Departments

Each department in which radioactive material or equipment containing radioactive material is used is responsible for providing and maintaining:

- a. limited access to areas where the material or equipment is used or stored.
- b. equipment necessary to minimize exposure and possibility of contamination from radioactive materials, and to ensure compliance with the License and 902 KAR 100.
- c. instruments necessary to monitor the types of radiation to which personnel may be exposed.
- d. a clearly defined supervisor for each area using/storing the material or equipment.

### 3.4 Authorized Users

Authorized Users (AU) receive authority from the RSC to possess or use radioactive material, sources, or equipment as defined by the Radioactive Materials License. Only WKU Faculty/Staff may qualify as an AU.

#### A) Responsibilities

1. To submit a proposal (i.e. Radiation Work Permit) to the RSC, through the RSO, specifying the radioactive source or material including the individual possession limit, its intended use and disposition, and other information the RSO may deem necessary.
2. To inform the RSO of any proposed changes in materials, guidelines, or activities different from the approved ones.
3. To keep adequate up-to-date records of dispensing and disposal of radioactive material according to guidelines in this manual on forms that are either supplied by or approved by the RSO.
4. To maintain an up-to-date listing with the RSO of all Supervised Users (see Section 3.5).
5. To provide supervision for all Supervised Users under their authority.
6. To ensure that laboratory personnel wear the assigned monitoring devices (film badge, OSL, TLD, pocket dosimeter) or provide other prescribed monitoring samples (urinalysis), if required.
7. To ensure that laboratory personnel are properly instructed in the guidelines involving radiation sources.
8. To notify the RSO immediately of the theft or unaccountability of any radioactive material (including waste).
9. To notify the RSO immediately of overexposure or suspected overexposure, accidental skin contamination, inhalation, ingestion, or any other emergency involving radioactive material.
10. To establish appropriate guidelines to ensure compliance with the posting and labeling requirements of 902 KAR 100.
11. To ensure the necessary personal protective equipment is provided and maintained for their Supervised Users (e.g. lab coats, gloves, tongs, bench pads, radiation shields, etc).
12. To establish a radioisotope-laboratory "close-down" procedure adequate to ensure that at the end of the work-day (which shall only apply to areas where "open-source" radioactive materials are used):
  - a. Survey measurements and/or wipe tests are conducted to establish that external radiation and contamination levels are within permissible limits.
  - b. Radiation sources are properly labeled and stored.
  - c. Experiments that will be in progress after normal work hours will be properly attended.
  - d. Each area using or storing radioisotopes is secured against unauthorized access.

13. Ensure that any of their Supervised Users that wish to declare pregnancy do so in writing to the RSO (i.e. as defined by 10 CFR 20.1003, KY in U.S. NRC Regulatory Guide 8.13 attached as Appendix N).
14. Additional requirements for radioactive gauge users are found in [Appendix B](#).

#### B) Authority

To accomplish the above responsibilities, Authorized Users have been given the following authorities:

1. To restrict laboratory activities involving radiation to those defined in the approved Radiation Work Permit (RWP).
2. To allow only Authorized or Supervised Users to handle or use radioactive materials, and/or ionizing radiation sources and allowing only authorized persons to enter rooms that are specified as restricted areas.

### 3.5 Supervised User – WKU Personnel

A Supervised User is appointed by the Authorized User who accepts supervisory responsibility for the Supervised User.

#### A) Responsibilities

1. To use radioactive material or equipment that emits ionizing radiation in a manner which complies with the guidelines and precautions contained in this document and with those established in the proposal (RWP) of the Authorized User under whom he/she works.
2. To control the radiation exposure to the lowest practical level and always below the levels in KAR 100:019.
3. To maintain laboratory records of the use and disposal of radioisotopes.
4. To be knowledgeable of emergency guidelines.
5. To notify the Authorized User immediately of any accident or spill involving radiation.
6. To practice laboratory techniques to control contamination of laboratory equipment and facilities.
7. To notify your Authorized User if you (female users) wish to declare pregnancy.

### 3.6 Supervised Users – Non-WKU Personnel

Supervised Users that are non-WKU Personnel are appointed by the Principal Investigator who accepts supervisory responsibility for the Authorized User.

#### A) Responsibilities

1. To use radioactive material or equipment that emits ionizing radiation in a manner which complies with the guidelines and precautions contained in this document and with those established in the proposal (RWP) of the Authorized User under whom he/she works.
2. To control the radiation exposure to the lowest practical level and always below the levels in KAR 100:019.

3. To maintain laboratory records of the use and disposal of radioisotopes.
4. To be knowledgeable of emergency guidelines.
5. To notify the Authorized User immediately of any accident or spill involving radiation.
6. To practice laboratory techniques to control contamination of laboratory equipment and facilities.
7. To notify your Authorized User if you (female users) wish to declare pregnancy.
8. Prior dose history must be submitted to the RSO.
9. May use dosimetry provided by non-WKU employer provided dosimetry is appropriate for the type of radiation expected and employer copies dosimetry results to WKU RSO at the end of each monitoring period (i.e., monthly, quarterly).
10. Dosimetry will be issued by WKU RSO if no dosimetry currently possessed by individual
11. Must complete WKU Radiation Safety Training as provided by the RSO.

### **3.7 Visitors**

Visitors may need to be in areas containing radioactive materials. In such cases, the visitor must have proper dosimetry (if needed), and be under direct physical supervision of the AU.

## **4. RADIATION SAFETY TRAINING REQUIREMENTS**

### **4.1 INITIAL RADIATION SAFETY TRAINING**

#### **A) Radioactive Material Users**

Initial radiation safety training is required for all radiation workers prior to the use of any licensable quantities of radioactive material. This training is also a prerequisite to obtaining a personal dosimeter. The initial radiation training may be provided as a combination of both online and classroom training.

If you have any questions, contact the RSO at (270) 745-3597.

Training topics shall include, as applicable:

- General radioactive materials safety
- Personnel dose monitoring program
- Radiation and contamination survey program
- Accident, incident, and emergency guidelines
- Radioactive material ordering, receipt, and package opening guidelines
- Storage and security
- Use of radioactive materials
- Radioactive waste storage, disposal, packaging, etc.
- Transportation
- Applicable state and federal rules and regulations and radioactive material license conditions

Authorized Users shall train all users under their supervision on specific guidelines relating to use of the radioactive material/equipment that they are licensed to use.

B) Ancillary Personnel

Ancillary personnel are those individuals at WKU that do not use radioactive material, but whose job duties may require them to work in the vicinity of radioactive materials. Ancillary personnel may include faculty, office staff, environmental services attendants (ESA), maintenance staff, etc. These individuals are required to receive an initial radiation safety awareness training provided by the RSO before assuming duties in the vicinity of radioactive materials.

Training topics shall include:

- Applicable portions of the radioactive material license pertinent to radiation safety
- Identification of areas where radioactive material is used or stored
- Potential hazards associated with radioactive material
- Radiological safety guidelines appropriate to their respective duties
- Pertinent state and federal regulations
- Rules and guidelines of the license
- Obligation to report unsafe conditions to the RSO
- Appropriate response to emergencies or unsafe conditions
- Right to be informed of their radiation exposure and bioassay results, as applicable
- Locations where the licensee has posted or made available notices, copies of pertinent regulations, and copies of pertinent licenses and license conditions (including applications and applicable correspondence), as required by [902 KAR 100:165](#).

## 4.2 RADIATION SAFETY REFRESHER TRAINING

### A. Radioactive Material Users

Individuals using licensed quantities of radioactive material are required to repeat annual radiation safety training. If a licensed user has not used or will not be using radioactive material for longer than one year, repeating annual training is not required. However, this user is required to complete training prior to resuming use. Contact the RSO at (270) 745-3597 for more information regarding the training needs for a particular department or job function.

### B. Ancillary Personnel

Periodic refresher training will be provided ancillary personnel as deemed necessary by the RSO.

## 4.3 INDIVIDUALS WHO OPERATE GAUGES

### A. Niton Portable XRF Gauge Users

Users of the Niton portable XRF shall, at a minimum, read and be familiar with the manufacturer's radiation safety and operating procedures as presented in the user's manual. Hands-on training in the safe use of the XRF shall be provided by the RSO. Where feasible, it is recommended that the user

attend training provided by Thermo Niton, which addresses radiation safety and operating procedures. If the manufacturer training is attended, the user shall still meet with the RSO to discuss WKU-specific requirements for use of the XRF.

**B. Fixed Gauge Users**

Users involved in the routine operation (this does not include maintenance, repair, installation, etc.) of a fixed gauge shall receive training from the gauge manufacturer prior to operation. This can be received at the time of gauge installation. Subsequent training for new users shall be arranged through the manufacturer unless alternate training is approved by the KY Radiation Health Branch. Training provided by the WKU RSO regarding WKU-specific requirements must also be completed prior to operation.

## **5. UNIVERSAL SAFETY GUIDELINES AND REQUIREMENTS**

### **5.1 ALARA**

An essential (and required) component of the radiation safety program is the use of ALARA to keep radiation doses to employees and members of the public as low as possible. The three primary ways to achieve ALARA are time, distance, and shielding. Each of these is described in more detail below. More detail on ALARA action levels is located in Section 6 of this manual.

**A. Time**

Radiation dose is directly proportional to the length of time an individual is exposed to a source of ionizing radiation. Therefore, the less time spent near a radiation source, the smaller the total dose received.

**B. Distance**

Distance is one of the simplest and most effective means of reducing radiation exposure. The relationship between distance and dose rate from a radiation point source follows the inverse square law. This means, that as a rough approximation, doubling the distance from a point radiation source can reduce the exposure rate by up to a factor of 4. Therefore, increasing the distance from the radiation source can significantly reduce radiation exposure. The use of tongs or other handling devices that increase distance from radioactive material during manipulation can significantly reduce extremity and body exposures.

**C. Shielding**

Properly shielding sources of radiation and/or personnel working near a source of radiation can dramatically reduce radiation exposure. It is important to choose shielding appropriate for the type of radiation and use involved. Shielding is available in a variety of forms for various applications. Contact the RSO for guidance regarding shielding types, application, and suppliers.

## 5.2 RADIATION SIGNS AND LABELS

There are various radiation signs and labels that are required to be used according to [902 KAR 100:019](#). These include radioactive material labels, radiation area signs, etc.

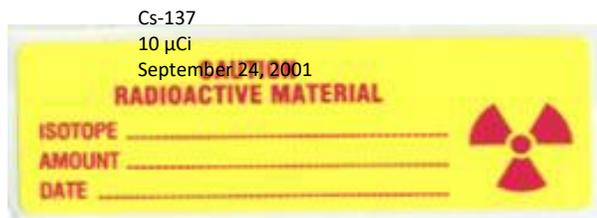
### A. Radioactive Material Use or Storage Areas

Each area storing or using radioactive material shall be posted by the RSO or under the direction of the RSO. These signs shall be removed only by, or with the approval of, the RSO. The RSO shall also be notified when posting/labeling signs need to be replaced. A conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" must be posted in an area or room in which there is used or stored an amount of licensed material exceeding ten (10) times the quantity of the material specified in 902 KAR 100:030. For example, 902 KAR 100:030 specifies 10  $\mu\text{Ci}$  for  $^{137}\text{Cs}$ . So, a location using or storing more than 100  $\mu\text{Ci}$  of  $^{137}\text{Cs}$  would require a posting like that pictured below.



### B. Labeling of Sources or Containers of Radioactive Materials

A radioactive source or a container holding a radioactive source must be labeled "Caution, Radioactive Material" if the activity in the source or container equals or exceeds the values stated in 902 KAR 100:030. For example, 902 KAR 100:030 specifies 10  $\mu\text{Ci}$  for  $^{137}\text{Cs}$ . So a 10  $\mu\text{Ci}$  source of  $^{137}\text{Cs}$  or a container with a total of 10  $\mu\text{Ci}$  or more within would require a label indicating "Caution, Radioactive Material." In addition to this wording, the radionuclide name, activity, and date of the activity are required. The label for the example  $^{137}\text{Cs}$  source would look something like this:



### C. Labeling of Equipment Containing Neutron Generators

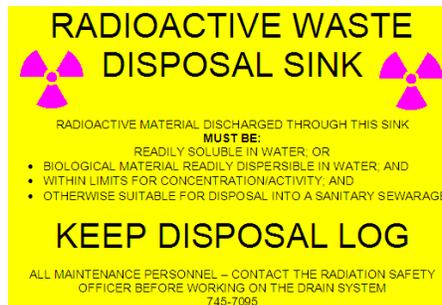
Equipment containing neutron generators must have the following label placed on its exterior as near as possible to the neutron production location.



#### D. Hot Sink Labeling

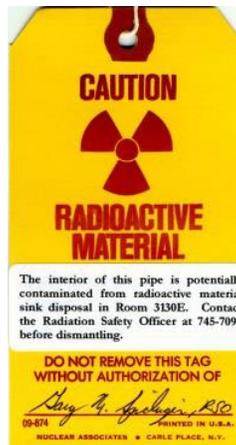
##### 1) Hot Sinks

Designated hot sinks shall be labeled with the following or similar label.



##### 2) Drains from Hot Sinks

The drain pipe leading from the hot sink should be labeled at its accessible points throughout the building with a label similar to that pictured below.

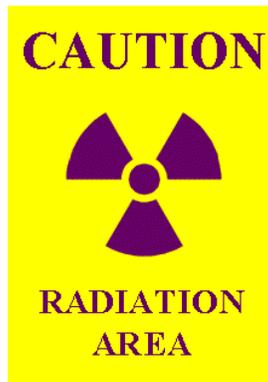


### E. Radiation Areas

The following signs must be used to post Radiation Areas, High Radiation Areas and Very High Radiation Areas. The definition of each type of area and an appropriate example of a sign for that type of area appear below.

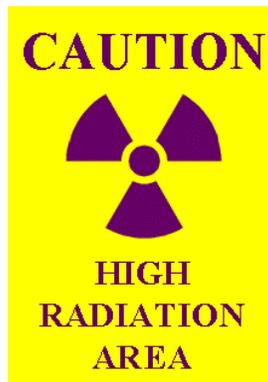
#### Radiation Area

An area, accessible to individuals, in which there exists radiation at levels that an individual may receive in excess of five (5) mrem in one (1) hour at thirty (30) centimeters from the radiation source or from a surface that the radiation penetrates.



#### High Radiation Area

An area, accessible to individuals, in which radiation levels may result in an individual receiving a dose equivalent in excess of 100 mrem in one (1) hour at thirty (30) centimeters from the radiation source or from a surface that the radiation penetrates.



#### Very High Radiation Area

An area, accessible to individuals, in which radiation levels may result in an individual receiving an absorbed dose in excess of 500 rads in one (1) hour at one (1) meter from a radiation source or from a surface that the radiation penetrates. At very high doses received, per NRC regulations, units of absorbed dose (such as rads) are more appropriate than units of dose equivalent (such as rems).



**Airborne Radioactivity Area**

A room, enclosure, or area in which airborne radioactive material exists in concentrations:

- In excess of the derived air concentrations specified in 902 KAR 100:019; or
- That an individual present in the area without respiratory protective equipment may exceed an intake of six-tenths (0.6) percent of the annual limit on intake, equivalent to twelve (12) DAC-hours



**5.3 LEAK TESTING**

Leak testing is to be conducted every 3 months for sealed or foil alpha-emitting radioactive sources. Beta and/or gamma-emitting sealed or foil sources must be leak tested every 6 months. In both cases the leak test analysis must be capable of detecting the presence of 0.005  $\mu\text{Ci}$  of radioactivity on the leak test media.

If the leak test reveals the presence of 0.005  $\mu\text{Ci}$  or more of removable contamination, the source must be immediately withdrawn from use. The source must then be decontaminated, repaired, or properly disposed as radioactive waste. All equipment which has been in contact with the leaking source shall be checked for contamination and decontaminated. A report within five (5) days of the test describing the equipment involved, the test results and the corrective actions taken shall be filed with the KY Radiation Health Branch, as indicated by 902 KAR 100.

Leak testing shall be done by the RSO or an approved vendor.

Whole Body and Collar Dosimeters provide measurement of penetrating and non-penetrating radiation exposure. Penetrating radiation is designated on reports as “DDE” for deep dose equivalent and includes exposure to the whole body (head, trunk, active blood-forming organs, and reproductive organs). Non-penetrating radiation is designated as “SDE” for shallow dose equivalent, and includes exposure to the skin and extremities. Lens of the eye dose equivalent is designated as “LDE.” Whole body dosimeters are to be worn on the torso in the region likely to receive the highest radiation exposure. If a protective lead apron is worn, wear the whole body dosimeter underneath your lead apron. Collar dosimeters are to be worn at the collar and external to a thyroid shield or lead apron.

Ring dosimeters provide measurement of radiation exposure to the extremities (hands and forearms). The ring dosimeter is to be worn under any gloves and on the hand most likely to receive the highest radiation dose.

#### **5.4 SEALED SOURCE INVENTORY**

A physical inventory is required every six months to account for all licensed sealed sources. The inventory must include the radionuclides, activities, manufacturer’s name and model numbers, the location of the sealed sources, the date(s) of the inventory, and the name of the individual conducting the inventory. Though not required by license, the WKU semi-annual physical inventory also accounts for all license-exempt sealed sources.

#### **5.5 UNSEALED SOURCE INVENTORY**

Please refer to [Section 16. Radioactive Waste](#) for a description of the use and disposal records that must be maintained for unsealed source use. The forms described will provide the mechanism for reporting unsealed source inventories on a monthly basis during active use periods.

#### **5.6 GENERAL RULES FOR SAFE USE OF RADIOACTIVE MATERIAL**

- Wear a laboratory coat or other protective clothing at all times in areas where unsealed radioisotopes are used.
- Wear disposable gloves at all times when handling unsealed radioisotopes.
- After each procedure using unsealed radioisotopes or before leaving the area, monitor hands, shoes, and clothing for contamination.
- Do not eat, drink, smoke or apply cosmetics in any area where radioactive material is stored or used.
- Do not store food, drink or personal effects in areas where radioactive material or used.
- Wear personal dosimetry, if required, at all times while in areas where licensed radioactive materials are used or stored.
- Dispose of radioactive waste only in designated, labeled and properly shielded receptacles or in designated hot sinks.
- Never pipette radioactive solutions by mouth.
- Store radioactive materials/solutions in container clearly labeled with the name of the compound, radionuclide, activity and date of the activity.

- Secure all radioactive material when it is not under the constant surveillance and immediate control of the user(s).
- Whenever practical, the user(s) should perform a trial experimental run using stable (or low activity) material to establish the adequacy of guidelines and equipment.
- When performing operations that might produce airborne contamination (i.e., transfers of unsealed powdered or volatile radioactive material), approved exhaust ventilation shall be used. When recommended by the RSO, filtration for effluent air or the containment of activity by glove bags or glove boxes shall be provided.
- Use plastic-backed absorbent pads on work benches when practical.

## **5.7 FUME HOODS**

Radioactive material operations producing aerosols volatile compounds, or fine dusts should be performed in a fume hood that has a currently dated flow check sticker. Contact the RSO for additional information on specific use requirements, or to schedule an airflow performance check.

## **5.8 FACILITY MAINTENANCE AND RENOVATION**

All facilities in which radioactive materials have been used or stored need to be surveyed by the RSO prior to maintenance or renovation activities. This survey is not required in areas that have already undergone a documented and approved decommissioning.

## **5.9 EQUIPMENT SERVICE AND SURPLUS**

Any equipment or items used to manipulate or store radioactive material must be free of radioactive contamination prior to disposal or being serviced. Contact the RSO for guidance on release surveys.

## **5.10 CALIBRATION REQUIREMENTS FOR RADIATION MONITORING INSTRUMENTS**

Radiation monitoring instruments used for quantitative radiation measurements are required, by regulation, to be calibrated annually. Survey instruments that have never been calibrated or are out-of-calibration cannot be used for quantitative radiation survey measurements. Instruments found out-of-calibration by the RSO will be tagged as "out-of-service." Instrument calibrations must be performed by an appropriately licensed vendor.

## **5.11 WRITTEN OPERATING PROCEDURES AND/OR USER'S MANUALS**

Written operating/use procedures and applicable user's manuals must be located such that any user can refer to these documents quickly when needed.

## **5.12 OTHER REQUIRED POSTINGS**

The following additional items are required to be posted conspicuously in each radioactive materials use area. If it is not practical to post these items, a notice must be posted that indicates where the documents can be viewed or obtained. If you need assistance obtaining these postings, please contact the RSO.

**A. KY Administrative Regulations**

- 902 KAR 100:019 – Standards for Protection Against Radiation
- 902 KAR 100:165 – Notices, Reports, and Instructions to Employees

**B. Radioactive Material License**

## 6. DOSE LIMITS AND ASSESSMENT

### 6.1 MAXIMUM PERMISSIBLE DOSE LIMITS

Exposure to ionizing radiation, both internal and external, shall be kept As Low As Reasonably Achievable (ALARA). All radiation users shall make every reasonable effort to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable. The term “as low as reasonably achievable” means as low as is reasonably achievable taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, other societal and socioeconomic considerations, and in relation to the utilization of sources of radiation in the public interest. The external and internal exposure from sources of radiation shall be controlled in such a way as to provide reasonable assurance that no individual shall receive an absorbed dose in excess of the values stated in 902 KAR 100:019.

**A. Radiation Workers**

Maximum permissible dose limits for adult radiation workers (listed below) apply to any combination of dose received from external or internal exposure. These limits do not apply to doses received from background radiation or from medical procedures or exams. An adult radiation worker is defined as an individual 18 years of age or older that works with or around sources of radiation.

<b>Annual Occupational Dose Limits for Adults</b>		
5,000 mrem (5 rem)	50 mSv (0.05 Sv)	Total Effective Dose Equivalent (TEDE)
50,000 mrem (50 rem)	500 mSv (0.5 Sv)	Shallow Dose Equivalent (SDE)
15,000 mrem (15 rem)	150 mSv (0.15 Sv)	Lens of Eye Dose Equivalent (LDE)
50,000 mrem (50 rem)	500 mSv (0.5 Sv)	DDE + CEDE to any individual organ or tissue other than the eye

### B. Declared Pregnant Radiation Worker

Under state and federal law, TEDE of a pregnant radiation worker remains at 5,000 mrem (50 mSv) per year until she specifically declares her pregnancy in a written and signed statement directed to the RSO. The declaration is voluntary. Following the RSO's receipt of a signed pregnancy declaration (SPD), the dose limit to the worker's embryo/fetus is limited to 500 mrem (5 mSv) for the duration of the pregnancy. Upon the receipt of a signed pregnancy declaration, the RSO will provide monitoring for potential internal and/or external exposure to the embryo/fetus as appropriate. A copy of the pregnancy declaration form is available in [Appendix N](#) of this manual.

The RSO recommends that a pregnant radiation worker declare her pregnancy so that her occupational radiation exposure potential can be evaluated to ensure that the dose to the unborn child does not exceed 500 mrem (5 mSv) over the duration of the pregnancy.

### C. Minor Radiation Worker

The maximum permissible dose limits for individuals under the age 18 are 10% of the adult limits specified above. Child labor laws prohibit individuals under the age of 18 from working with certain types of radioactive materials or in certain areas where occupational radiation exposure may occur. It is the policy of EHS that minors are not normally permitted to work with sources of ionizing radiation at WKU. For more information regarding this policy, contact the Radiation Safety Officer at 270-745-3597.

### D. General Public

The Total Effective Dose Equivalent (TEDE) to a member of the general public (including employees not involved in working with sources of ionizing radiation) is 100 mrem (1 mSv) per year from licensed or registered activities at WKU. In addition, the dose to a member of the public from external radiation shall not exceed 2 mrem in any one hour.

## 6.2 ALARA PROGRAM

The maximum permissible occupational dose limits established by regulation are based on limiting individual radiation dose to what is considered to be an acceptable level of occupational risk. Although there is no documented evidence linking any health effect with exposures less than 10,000 mrem (100 mSv) delivered at a high dose rate, it is assumed that any radiation exposure may carry some risk. Therefore, regulation requires that the University provide a program designed to reduce exposures As Low As Reasonably Achievable (ALARA) to the extent practical, utilizing procedural and engineering controls.

The University's ALARA Program provides a process for the RSC and the RSO to review the radiation safety program annually, review all proposals (this is done by the RSO) for radioactive material usage, review all occupational radiation exposure reports, and investigate any occurrences where occupational exposures exceed established program action levels.

### 6.3 ACTION LEVELS

The University has established investigational levels for occupational exposure to radiation.

A) Operational Action Level

The RSO contacts individuals and their supervisor/department head if their monthly/quarterly exposure exceeds any of the action levels listed in the following table.

B) Action Level I

In addition to “Operational Action Level” notifications, the RSO requires the completion of a questionnaire for “Action Level I” exposures.

C) Action Level II

In addition to operational and Level I actions the RSO requires a meeting with the staff member and supervisor regarding exposures in this category.

<b>Action Levels (per calendar quarter)</b>			
	<b>Operational</b>	<b>Level I</b>	<b>Level II</b>
TEDE	<i>125 mrem (1.25 mSv)</i>	<i>375 mrem (3.75 mSv)</i>	<i>625 mrem (6.25 mSv)</i>
SDE	<i>1,250 mrem (12.5 mSv)</i>	<i>3,750 mrem (37.5 mSv)</i>	<i>6,250 mrem (62.5 mSv)</i>
LDE	<i>375 mrem (3.75 mSv)</i>	<i>1,125 mrem (11.25 mSv)</i>	<i>1,875 mrem (18.75 mSv)</i>
DDE + CEDE <i>(Any organ or tissue other than the eye)</i>	<i>1,250 mrem (12.5 mSv)</i>	<i>3,750 mrem (37.5 mSv)</i>	<i>6,250 mrem (62.5 mSv)</i>

D) Action levels for minors

The action levels for minors are 10% of limits listed above.

E) Action Levels for declared pregnant Worker

The action levels for a declared pregnant worker are

- Operational: 5 mrem / month
- Level I: 15 mrem/month
- Level II: 25 mrem/month

### 6.4 DETERMINATION OF EXPOSURE

Personal dosimeters used to record occupational radiation exposures are supplied and processed through an NVLAP (National Voluntary Laboratory Accreditation Program)-approved commercial dosimeter service. The administration and management of the personnel monitoring program is

provided by RSO. Personal dosimeters are assigned to individuals based upon regulatory requirements and their potential for occupational exposure to penetrating radiation. Dosimeters are also available upon request regardless of regulatory requirements. Dosimeters are normally exchanged on a monthly or quarterly basis. Annual summaries of dosimetry reports are provided to each dosimeter holder and are maintained on file by the RSO. Contact the RSO if you have questions concerning dosimeters or dosimeter reporting.

Documented completion of radiation safety training applicable to job function is required as a prerequisite to obtaining a personal dosimeter.

#### A. Conditions Requiring External Dosimetry

Dosimetry is required for

- Adults likely to receive, in one year from sources external to the body, a dose in excess of ten percent of the limits specified in this section.
- Declared pregnant women likely to receive, in one year from sources external to the body, a dose in excess of ten percent of the applicable limits specified in this section.
- Individuals entering a high or very high radiation area.

#### B. Types of Dosimeters

##### **Whole Body**

Whole body dosimeters provide measurement of penetrating and non-penetrating radiation dose. Penetrating radiation is designated on reports as “DDE” for deep dose equivalent and includes exposure to the whole body (head, trunk, active blood-forming organs, and reproductive organs). Non-penetrating radiation is designated as “SDE” for shallow dose equivalent, and includes exposure to the skin and extremities. Lens of the eye dose equivalent is designated as “LDE.” Whole body dosimeters are to be worn on the torso in the region likely to receive the highest radiation exposure.

##### **Ring Dosimeters**

Ring dosimeters provide measurement of radiation exposure to the extremities (hands and forearms). The ring dosimeter is to be worn under your disposable glove, if applicable, and on the hand most likely to receive the highest radiation dose.

##### **Other Dosimeters**

Dosimeters are also available for other extremities. Contact the RSO to discuss these other dosimeter types.

## 6.5 DETERMINATION OF INTERNAL EXPOSURE

### A. Bioassays

Thyroid and/or urine bioassays are performed for personnel for whom internal exposure to radioactive materials is considered most likely.

Bioassays are normally performed for:

- Individuals using large quantities of open (unsealed) radioactive materials as determined by the RSO.
- Declared pregnant radiation workers working with unsealed radioactive material.
- Individuals with an accidental or suspected intake of radioactive material.

Monitoring of the occupational intake (internal exposure) is required for:

1. Adults likely to receive, in one (1) year, an intake in excess of ten (10) percent of the applicable ALIs in from 10 CFR 20, Appendix B as referenced by Section 44 of 902 KAR 100:019.
2. Declared pregnant women likely to receive, in one (1) year, a committed effective dose equivalent in excess of 0.05 rem (five-tenths (0.5) mSv).

### B. Accidental Internal Exposure Assessment

Anyone suspecting that they have had an intake of radioactive material through any pathway (e.g., ingestion, injection, inhalation, or skin absorption) should contact the RSO immediately at 270-745-3597 so that an evaluation can be performed.

## 7. OBTAINING AUTHORIZATION

### 7.1 USE OF RADIOACTIVE MATERIALS

WKU faculty/staff requesting authorization to use licensed radioactive material for any reason shall obtain approval from the WKU Radiation Safety Committee (RSC) prior to assuming responsibility for the material. Permission to obtain and use license-exempt radioactive material shall be received from the WKU Radiation Safety Officer.

Prospective individuals appointed to serve as the WKU RSO must obtain approval from the CHFS prior to assuming any one of these responsibilities.

### 7.2 AUTHORIZED USER APPLICATION

Faculty/staff requesting permission to possess licensed radioactive materials must submit evidence of qualifications of training and experience to the RSC for review and approval prior to assuming responsibility.

Requests for approval to be an Authorized User must be made in writing. The Authorized User application is found in [Appendix C](#). The Authorized User application shall be submitted along with a Radiation Work Permit application ([Appendix D](#)). These written requests for authorization should be sent to the RSO.

*Note: The Authorized User application and Radiation Work Permit are submitted concurrently only for an individual's initial request to become an Authorized User. An individual typically submits the AU application only once. An RWP, however, is submitted any time the conditions detailed below are met.*

### **7.3 RADIATION WORK PERMIT INSTRUCTIONS**

If an AU wishes to use a licensed radioactive material at WKU, then he/she must have an approved Radiation Work Permit (RWP).

The RWP and its supporting documents (in [Appendix D](#)) shall be completed by the primary Authorized User and submitted to the RSO for review. The RSO shall then review and send copies of the RWP to all members of the Radiation Safety Committee (RSC) for their review. If the RWP is approved by the RSO and the RSC, then the AU shall be allowed to utilize the radioactive material under the conditions of the RWP and the WKU Radioactive Material License. If the Radiation Work Permit is for a radioisotope that is not currently on the WKU Radioactive Material License or in a building that is not currently on the license, an amendment request to add that isotope and/or building to the license will be sent to the KY Radiation Health Branch after its approval by the RSC. Only after the Branch has issued an amendment approving the new isotope and/or building shall the individual be able to use that isotope.

If the AU needs to make a change to the RWP after it has been approved, then he/she must submit an amendment request ([Appendix E](#)) or an entirely new RWP (depending on the amount of change required). The amended RWP will undergo the full approval process as previously described.

Authorized Users will be required to submit a new Radiation Work Permit once every 5 years. In addition, the RSO and/or RSC reserve the right to request updated information, as they deem appropriate, from an AU regarding their work with radioactive material.

## 8. ACQUISITION OF RADIOACTIVE MATERIALS

### 8.1 GENERAL REQUIREMENTS

No radioactive material or equipment containing radioactive material may be received without the prior written approval of the RSO and RSC.

This includes:

- Newly ordered material/equipment
- Material/equipment received from licensed transfer of material
- Material/equipment on loan
- Donated material/equipment

Radioactive materials are also required to be shipped to and received by the RSO.

### 8.2 PROCUREMENT

#### A. Licensable Radioactive Material

No licensable radioactive material shall be purchased using credit cards.

Prior to ordering licensed radioactive material, a Radioactive Material Acquisition Pre-Approval Form, located in [Appendix E](#), must be completed by the AU and submitted to the RSO for approval. Once this has been approved, the RSO shall return the completed form to the AU and forward a copy to the WKU Department of Purchasing. The AU may then proceed with the submission of an online purchase requisition in Banner.

If recurring radioisotope acquisitions are anticipated for a given WKU fiscal year, then a standing purchase order should be requested. A standing purchase order would allow the AU to specify the anticipated total activity and cost of radioisotope to be acquired during the current fiscal year. If a standing order is set up, the AU must notify the RSO before each radioisotope order, but the purchase order will already be in place with the vendor. Upon notification of the RSO, the AU may place the radioisotope order by telephone or fax by referencing the existing standing purchase order number. This procedure allows for a more efficient and timely ordering and receipt of routine licensed radioisotope purchases.

Purchase requisitions should not be processed without the completed Radioactive Material Pre-Approval Form. The ordering Authorized User shall send the RSO a copy of the purchase order immediately following its receipt from Purchasing. No radioactive materials may be ordered prior to this transaction occurring, including purchases made with grant funds.

When a purchase requisition is entered, the “Ship To:” code must be changed to Environmental Health and Safety. The “Attention To” line should indicate Radiation Safety Officer.

**B. License-Exempt Radioactive Material**

License-exempt radioactive materials may be purchased either by online requisition or by the use of a WKU-issued credit card. For license-exempt radioactive materials Radioactive Material Acquisition Pre-Approval Form does not need to be filled out, but RSO approval must still be obtained before the order is placed. This request for approval must be submitted to the RSO in writing (via e-mail is preferred) and the approval given in writing (also via e-mail). If you are unsure whether the quantity of radioactive material you would like to purchase is license-exempt, please contact the RSO.

When a credit card is used as the order/payment method, the delivery address given the vendor must be:

Radiation Safety Officer  
Western Kentucky University  
1906 College Heights Boulevard #11046  
Bowling Green, KY 42101

### **8.3 ADDITIONAL ACQUISITION NOTES**

Written records for all ordering and receipt must be maintained.

During normal working hours, radioactive packages are delivered to the Department of Shipping and Receiving. Shipping and Receiving notifies the RSO of the arrival of the package. At that point, the RSO will ensure the package is acceptable and that all pertinent records are retained, and shall then deliver the package to the appropriate AU. In certain instances, the RSO may help the AU to arrange delivery of the radioactive material directly to the applicable radiation lab.

During off-duty hours (before 8 a.m., after 4:30 p.m., or any time on weekends) no delivery of radioactive packages shall be accepted. If a delivery is needed during normal off-duty hours, provide the RSO at least seven days’ advance notice.

## **9. PACKAGE RECEIVING AND OPENING REQUIREMENTS**

### **9.1 MONITORING REQUIREMENTS**

Upon receipt of

- a labeled package containing radioactive material in excess of Type A\*\* quantity limits,
- any package containing liquid radioactive material in excess of exempt quantities as specified in 902 KAR 100:080 and 085 and/or
- any radioactive materials’ /package (regardless of quantity limits) that arrives in a crushed, wet, or otherwise damaged condition,

the following must occur:

- Put on gloves to prevent hand contamination
- Visually inspect package for any sign of damage (e.g., wetness, crushed). If damage is noted, stop procedure and notify RSO.
- Measure the radiation level at 1 meter from the external surface of the package. If the measured radiation levels exceed the limits specified in Table 9-2, stop procedure and notify the RSO.
- Measure the radiation level at the surface of the package. If the measured radiation levels exceed the limits specified in Table 9-2, stop the procedure and notify the RSO.
- Wipe test the external surface of the package for removable radioactive contamination, unless the package contains only radioactive material in the form of a gas or in special form; if the measured removable contamination exceeds the limits specified in Table 9-1, stop the procedure and notify the RSO.
- Open the package with the following precautionary steps:
  - Place a package containing a volatile compound in a fume hood before proceeding.
  - Open the outer package according to the vendor's directions (if available) and remove the packing slip.
  - Open the inner package and verify that the contents agree with those on the packing slip.
  - Check the integrity of the final source container (i.e., inspect for breakage of seals, source capsules, vials, loss of liquid, discoloration of packing material, etc.)
  - Verify that the source activity does not exceed the possession limits specified in your Radiation Work Permit.
  - For unsealed sources only - Wipe test the external surface of the final source container to determine the amount of removable radioactivity (e.g., dpm/100 cm<sup>2</sup>, etc.). Take precautions against the spread of contamination as necessary.
  - For sealed sources only - If the radioactive material is a licensed sealed source and a current leak test (within last 3 months for alpha emitters and within last 6 months for beta/gamma emitters) is not included in the shipment, then the source itself must be leak tested before use. The leak test shall show no removable contamination above 0.005  $\mu$ Ci.
- Monitor the packing material and packages for contamination before discarding.
- If contaminated, treat as radioactive waste.
- If not contaminated, obliterate radiation labels before discarding in regular trash.
- Record all of the monitoring results for the package using the "Radioactive Shipment Receipt Report" found in [Appendix G](#).
- The monitoring must take place as soon as practical, but no later than 3 hours after package receipt if it is received during normal working hours. If the package is received after normal working hours the monitoring must take place no later than 3 hours from the beginning of the next working day.

## 9.2 EXCEPTIONS TO THE MONITORING REQUIREMENTS

No specific surveys or wipe tests are required:

- For packages containing non-liquid radioactive material in quantities less than the Type A limits
- Non-liquid tritium sources (including D-T neutron generator accelerator heads)

### 9.3 EMERGENCY NOTIFICATIONS

The final delivery carrier and the KY Radiation Health Branch will be notified if:

- Removable surface contamination exceeds the limits specified in Table 9-1
- External radiation levels exceed the limits specified in Table 9-2
- Leak test results for a sealed source are in excess of 0.005  $\mu\text{Ci}$

Table 9-1

Contaminant	Maximum permissible limits	
	$\mu\text{Ci}/\text{cm}^2$	dpm/cm <sup>2</sup>
Beta and gamma emitters and low toxicity alpha emitters	$10^{-4}$	220
All other alpha emitting radionuclides	$10^{-5}$	22

Table 9-2

Package Shipping Label	Label Image	Maximum permissible limit for package external surface radiation level (mrem/hr)	Maximum permissible limit for radiation level at 1 meter (mrem/hr)
Radioactive – White I		0.5	0.05
Radioactive – Yellow II		50	1
Radioactive – Yellow III		200	10
Radioactive – Yellow III (shipped under exclusive use provisions)		1000	>10

\*\*NOTE: Current Type A quantity limits can be found in 49 CFR 173.435, Table of A1 and A2 values for radionuclides

## 10. STORAGE AND SECURITY OF RADIOACTIVE MATERIALS

Radioactive material shall be stored in a manner that:

- a. Provides adequate radiation shielding such that:
  - In an uncontrolled area, the radiation levels are within the limits as set forth in Section 6 of this manual.
  - In a controlled area, the occupational dose received from stored activity is less than 10% of the specified dose levels as set forth in Section 6 of this manual.
- b. Provides adequate protection against fire, explosion, or flooding
- c. Provides adequate protection against accidental breakage of primary storage containers
- d. Provides adequate protection against unauthorized use or removal

Radioisotopes shall not be left unattended in places where unauthorized persons may handle them or take them without realizing that they are radioactive.

## 11. UNSEALED SOURCE CONTAMINATION SURVEYS

Contamination surveys must be conducted periodically in and around areas where unsealed radioactive material is used. These surveys are an essential part of contamination control to prevent the unnecessary spread of contamination to personnel, equipment, and work areas. Routine documentation of contamination levels can also help to simplify the decommissioning process when a radiation lab is released to non-radiation uses.

Table 11-1 specifies acceptable removable contamination limits for unsealed source use areas, equipment, etc. The values specified are maximum values and the actual contamination levels must also be maintained “As Low As Reasonably Achievable” (ALARA).

Table 11-1: Acceptable Removable Surface Contamination Levels

Contaminant	Acceptable Removable Contamination Levels (dpm/100 cm <sup>2</sup> )
Beta or gamma emitter	1000
Natural Uranium, <sup>235</sup> U, <sup>238</sup> U and associated decay products	1000
Note: This table is adapted from Table I of NRC Regulatory Guide 1.86	

## 11.1 CONTAMINATION SURVEY FREQUENCY

### A) Daily Meter Surveys

Each day an unsealed source is used, a survey must be conducted using instrumentation appropriate to the isotope used. A thin window GM probe survey meter (e.g., pancake or end-window) is appropriate for most alpha, beta, and gamma emitters with the exception of  $^3\text{H}$ . A wipe test analyzed on a liquid scintillation analyzer is the only acceptable survey method for  $^3\text{H}$ . The daily survey is conducted to see if any locations have gross contamination. Contamination is considered present if the survey reveals count rates at twice the background count rate. Only count rate data for each location need be recorded for the daily surveys.

### B) Weekly Wipe Test Surveys

In addition to the daily surveys required above, weekly wipe test surveys are required when a radioisotope is used in an activity exceeding 250  $\mu\text{Ci}$  per week. The wipe test survey should include areas most likely to have contamination. In addition, any location that was identified in the daily survey as contaminated must be included in the wipe test survey. If a wipe test result reveal contamination in excess of Table 11-1 values, decontamination is required. The wipe test survey data must be recorded in cpm, dpm and dpm/100  $\text{cm}^2$ .

Surveys for gamma contamination shall additionally quantify the dose rate. The gamma dose rate survey shall be conducted with an appropriate survey meter calibrated to read in mR/hr. The dose rate shall be kept below 0.5 mR/hr.

### C) Monthly Wipe Test Surveys

In addition to the daily surveys required by Section 11.1.A, monthly wipe test surveys are required when a radioisotope is used in an activity less than 250  $\mu\text{Ci}$  per week. The wipe test survey should include areas most likely to have contamination. In addition, any location that was identified in the daily survey as contaminated must be included in the wipe test survey. If a wipe test result reveals contamination in excess of Table 11-1 values, decontamination is required. The wipe test survey data must be recorded in cpm, dpm and dpm/100  $\text{cm}^2$ .

Surveys for gamma contamination shall additionally quantify the dose rate. The gamma dose rate survey shall be conducted with an appropriate survey meter calibrated to read in mR/hr. The dose rate shall be kept below 0.5 mR/hr.

### D) Contamination Survey Frequency Notes

The activity limits that determine whether weekly or monthly wipe test surveys are required may be reduced below the 250  $\mu\text{Ci}$  limit by the RSO for certain isotopes (e.g., I-125 or I-131).

[Appendix J](#) contains a listing by department of currently available survey meters and other survey equipment.

## 11.2 COMMON CONTAMINATION SURVEY LOCATIONS

The following are typical survey locations:

- Bottom of shoes, lab coats, hands
- Floor at entrance to work area
- Door handle at entrance to work area
- Work area surfaces
- Floor in front of work area
- Lab sink
- Drawer and cabinet handles near work area
- Equipment used (pipettes, centrifuges, etc.)
- Waste storage container lid handles
- If work is conducted in a fume hood surveys shall include
  - Floor in front of fume hood
  - Fume hood apron
  - Fume hood sash handle
  - Work surface in fume hood
- Other locations not listed that are possible contamination locations.

## 11.3 WIPE TEST CONTAMINATION LIMITS

If the measured contamination level determined with a wipe test is above the value indicated in Table 11-1, decontaminate and re-survey the location. Document each decontamination and re-survey to reduce the measured contamination levels below the specified limits. Please remember that contamination levels need to be kept as low as possible below the maximum levels indicated in the tables.

## 11.4 SURVEY DOCUMENTATION

A permanent record must be kept of all survey results, including negative results. Use the form in [Appendix K](#) to record the survey results. You may create your own form provided it documents the same information as that in Appendix K. Any form used to document the surveys shall include the following information.

- Room number, survey date, and identification of survey equipment used, including the serial number and pertinent counting efficiencies.
- Name of person conducting the survey.
- A drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.
- Description of wipe test or scan survey locations
- Detected contamination levels (in units of cpm for meter scans and in units of dpm/100 cm<sup>2</sup> for wipe tests), keyed to locations on the drawing.
- Measured exposure rates (for gamma-emitting isotopes only), keyed to locations on the drawing.
- Identification of survey locations that exceed contamination levels or exposure rates.

- Corrective action taken in the case of contamination or excessive exposure rates, reduced contamination levels or exposure rate after corrective action, and any appropriate comments.

### 11.5 NOTES

- A Technical Instruction document for the execution of contamination surveys for beta-emitting isotopes is available from the RSO.
- Surface contamination of work areas and equipment can be minimized by paying close attention to laboratory hygiene. Remember to use plastic-backed absorbent bench paper instead of working directly on an uncovered surface. Change your protective gloves often and always before you handle items that you don't want contaminated (e.g., the radiation survey meter).
- $\text{dpm (disintegrations per minute)} = \text{cpm (counts per minute)} / \text{counter efficiency}$

## 12. TRANSPORTATION OF RADIOACTIVE MATERIALS

The transportation of radioactive material can be divided into roughly three categories. These are transportation of licensed radioactive material, transportation of license-exempt radioactive material by third party vendor, and transportation of license-exempt radioactive material by WKU employee.

The transportation of licensed radioactive material must comply with 902 KAR 100:070 and the Department of Transportation (DOT) regulations, in 49 CFR. The transportation of license-exempt radioactive material is not specifically addressed by 902 KAR 100. However, license exemption by KY radiation control regulations does not necessarily equate to exemption from the regulations issued by DOT for transportation purposes. The DOT exemption activity limits for the applicability of 49 CFR are different than the activity limits that define license exemption according to 902 KAR 100. The following sections define general requirements for each of the categories defined above.

Regardless of category, written approval must be obtained from the RSO prior to the transportation of any radioactive material. Your request for approval may be submitted in an e-mail detailing which source(s) is(are) to be transported, the destination, and when the source will be returned.

### 12.1 TRANSPORTATION OF LICENSED RADIOACTIVE MATERIAL

Licensed radioactive material, for transportation purposes, may end up being classified as a limited quantity, excepted shipment, Radioactive-White I, Radioactive-Yellow II, or Radioactive-Yellow III. The classification depends mostly upon the activity of the material shipped, measured package surface dose rates, and measured dose rates at 1 meter from the package surface (this is referred to as the Transport Index or TI). Each classification has specific requirements that may include labeling, marking, shipping documentation, tamper evident seals, placards, emergency response information, DOT certified packaging, loading instructions, etc.

If you participate in any activities that affect the transportation of a licensed radioactive material, you must have current DOT Hazmat training. These activities include packing, labeling, marking, shipping document preparation, loading or unloading packages, or driving the transportation vehicle. Current DOT Hazmat training is documented training received within the past three years and includes:

- General awareness and function specific training
- Security awareness training
- Safety training (e.g., radiation safety training)

Note: Any licensed radioactive material shipment that requires the vehicle to be placarded, such as the shipment of a package labeled Radioactive-Yellow III, must be transported only by a qualified third-party vendor. WKU personnel may not drive a placarded vehicle containing this type of package.

## **12.2 TRANSPORTATION OF LICENSE-EXEMPT RADIOACTIVE MATERIAL VIA THIRD PARTY**

The requirements for the transportation of licensed radioactive material also apply to shipments of license-exempt radioactive material via FedEx, UPS, Roadway, Overnight, etc.

## **12.3 TRANSPORTATION OF LICENSE-EXEMPT RADIOACTIVE MATERIAL VIA WKU EMPLOYEES**

Institutions such as government agencies and state universities, in general, are not held to the hazardous materials regulations (HMR) in 49 CFR when the transportation is conducted by an employee(s) of that institution for institution-related business. This has been clearly documented in interpretation letters written by the DOT. Simply stated, WKU is not held to the HMR if a WKU employee is driving (transporting) a hazardous material for WKU business. This does not hold for licensed radioactive material transportation as 902 KAR 100 specifically states that licensed radioactive materials shall be transported according to 49 CFR regardless of any other exemption.

Since 902 KAR 100 is silent on this issue for license-exempt radioactive material, WKU applies the DOT exemption from the HMR described above.

## **12.4 OTHER TRANSPORTATION NOTES**

Please contact the RSO for Standard Operating Procedures for the preparation and transportation of specific radioactive materials. If you require RSO assistance in the preparation of a radioactive material for transportation, please request that assistance at least 48 hours prior to the date you need the material to be shipped.

If the purpose of the radioactive material transportation is for use at a location not currently approved by the WKU Radioactive Material License, a request for reciprocity or a license transfer of materials may be required. Section 13 of this manual addresses the license transfer of radioactive materials. Section 14 addresses reciprocity.

## 13. TRANSFER OF RADIOACTIVE MATERIAL

### 13.1 ON-CAMPUS TRANSFERS

On-campus transfers of radioactive material are only permitted between Authorized Users. Transfer recipients must be currently licensed for the use location, radionuclide, chemical form and quantity of radioactive material they wish to receive. Prior to the transfer, complete and submit an "On-Campus Transfer of Radioactive Material" form to the RSO, located in [Appendix L](#). This form serves to document the exchange of inventory between the Authorized Users. Licensed radioactive material can be transferred in a WKU motor vehicle if applicable DOT regulations are followed. Please refer to Section 12 for details. If the material is not going to be moved to the transfer location by motor vehicle, please use these common sense guidelines when moving the material.

1. Carry unsealed solutions in the original stock vials when possible. When this is not possible, carry the solution(s) in a durable container. If the radioactive liquid is transported in a breakable container, it must be surrounded by enough absorbent material to readily soak up all the radioactive liquid.
2. Carry sources in an appropriately shielded container such that dose rates are as low as reasonably achievable.
3. Attach an appropriate radioactive material label reading "Caution Radioactive Material" to the outside of the container when the quantity being transferred exceeds the values indicated in Section 6 of this manual.
4. To lessen the chance of mishaps and to reduce exposure to members of the general population, movement of radioactivity should be restricted to periods when traffic in corridors and on stairs is light. Make transit time short. Avoid unnecessary stops along the way. Never leave radioactivity unattended in any place but an approved locked storage area. Also do not store radioactivity anywhere but authorized radiation laboratories and storage areas.
5. Check the container for contamination after removal of the source.
6. If a spill should occur outside the laboratory, contact the RSO and do not leave the area unattended unless it is necessary to render immediate emergency attention to personnel involved in the spill. Post a guard and restrict access to the contaminated area until such time as compliance with guidelines outlined in Section 15, "Emergencies," can be established.

### 13.2 OFF-CAMPUS TRANSFERS

Off-campus transfers are allowed only to authorized vendors and/or organizations licensed to possess the radioactive material to be transferred. If you wish to transfer a licensed radioactive material to another organization (including transfers to a vendor for repair), please fill out and submit the form in [Appendix M](#) to the RSO prior to the transfer. The RSO will contact the organization to obtain documentation, where necessary, verifying its authorization to receive the licensed material. Please refer to Section 12 for details on transportation requirements.

## 14. RECIPROCITY

Reciprocal recognition, or reciprocity, occurs when a radiation control agency from another state gives WKU approval to temporarily operate under its Kentucky Radioactive Material License in its state. If the intended use location is under the jurisdiction of the Nuclear Regulatory Commission (such as a Federal facility in Kentucky or another state) then the reciprocity application is submitted to the NRC. If the location is under the jurisdiction of an Agreement State, then the reciprocity application is submitted to that state's radiation control program.

If you need to apply for reciprocity for one or more of your licensed radioactive materials, please submit a Radiation Work Permit (found in [Appendix D](#)) to the RSO. Upon receipt of this RWP, the RSO will contact the appropriate radiation control agency to initiate the application for reciprocal recognition. The RSO will also forward the Radiation Work Permit to the WKU Radiation Safety Committee for consideration.

## 15. RADIOACTIVE MATERIAL EMERGENCY GUIDELINES

### 15.1 EMERGENCY PROCEDURES

Each radioactive material user must be ready and equipped to handle a radiological spill or emergency. Information and knowledge concerning the type of radioactive materials being used, the availability of adequate spill response supplies, and knowing when and who to call for assistance are all critical elements needed to effectively respond to any type of radioactive material incident. The RSO will initially provide a stocked spill kit for each lab that uses open sources of radioactivity. Each unsealed source use lab is required to have a stocked spill kit. Replenishment of the supplies in the spill kit is the responsibility of the department or laboratory.

It is the responsibility of the Authorized User to ensure that his/her personnel are trained and periodically practice spill or emergency response scenarios. The RSO is available to provide guidance, training, and support regarding spill and emergency response strategies and management.

In the case of a spill, the individuals causing the spill will be required to perform the major portion of the decontamination. The RSO will provide assistance as necessary.

At the conclusion of any spill cleanup or emergency, the individuals involved shall cooperate fully with the RSO in preparing whatever reports are required by the Federal, State, and local authorities.

Emergency Procedure Postings are Located in Appendices [P](#) and [Q](#).

These appendices provide radiation emergency procedures for sealed and unsealed source use areas, respectively. The appropriate procedure shall be posted in each licensed radioactive material use location or area.

## 15.2 NOTIFICATION OF INCIDENTS

### A. Immediate Notification

If any of the following occurs, immediately notify the RSO. The RSO will, in turn, immediately contact the KY Radiation Health Branch.

An event involving radioactive material possessed by WKU that may have caused, or threatens to cause, one (1) or more of the following conditions:

a. An individual may receive:

- a total effective dose equivalent of twenty-five (25) rems (0.25 Sv) or more;
- an eye dose equivalent of seventy-five (75) rems (0.75 Sv) or more; or
- A shallow-dose equivalent to the skin or extremities of 250 rads (two and five-tenths (2.5) Gy) or more;

b. The release of radioactive material, inside or outside of a restricted area; so that, had an individual been present for twenty-four (24) hours, the individual may have received an intake five (5) times the occupational annual limit on intake. The provisions of this paragraph shall not apply to locations in which personnel are not normally stationed during routine operations, such as in hot-cells or process enclosure;

c. A loss of one (1) working week or more of the operation of facilities affected; or

d. Damage to property in excess of \$200,000.

### B. Twenty-four (24) hour notification

The RSO must within twenty-four (24) hours of discovery of the event, report an event involving loss of control of licensed or registered source of radiation possessed by WKU that may have caused, or shall threaten to cause, one (1) or more of the following conditions:

a. An individual to receive, in a period of twenty-four (24) hours:

- A total effective dose equivalent exceeding five (5) rems (0.05 Sv);
- An eye dose equivalent exceeding fifteen (15) rems (0.15 Sv); or
- A shallow-dose equivalent to the skin or extremities exceeding fifty (50) rems (five-tenths (0.5) Sv);

- b. The release of radioactive material, inside or outside of a restricted area; so that, had an individual been present for twenty-four (24) hours, the individual may have received an intake in excess of one (1) occupational annual limit on intake. The provisions of this paragraph shall not apply to locations in which personnel are not normally stationed during routine operations, such as in hot-cells or process enclosures;
- c. A loss of one (1) day or more of the operation of facilities affected; or
- d. Damage to property in excess of \$2,000.

### C. Incident Notification Methods

The RSO, with the assistance of the applicable AU(s) and/or SU(s), shall prepare and file a report with the KY Radiation Health Branch so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

a. The RSO shall make reports to the cabinet by:

- Telephone;
- Mail;
- Email; or
- Facsimile.

## 16. RADIOACTIVE WASTE

All radioactive material which comes into WKU must be accounted for. It is imperative that accurate records of radioactive material use and disposal be kept. To provide accountability for the use and disposal of unsealed radioactive material, there are specific records that shall be kept by the AU and/or SU. These records are the Radioisotope Use/Disposal Record and the Hot Sink Disposal Record which are located in Appendices [H](#) and [J](#), respectively. All radioactive material must be disposed of in accordance with 902 KAR 100:021, the provisions in this manual, and any associated technical guidance issued by the RSO and/or the RSC. The final disposition of all radioactive waste, except aqueous radioactive waste disposed via sanitary sewer, must be by the RSO. Unless otherwise specified, the RSO will arrange the final removal, transportation, and disposal of radioactive waste through a licensed radioactive waste broker. Where it is not practical to store waste in the radiation lab generating the waste, the RSO will remove the waste to storage in Kelly Thompson Hall G008. In an effort to reduce the cost of disposal, do not put uncontaminated waste in containers specifically designated for radioactive waste. On-site incineration of radioactive waste shall not be done.

### 16.1 DISPOSAL IN THE SANITARY SEWER (“HOT SINKS”)

Water soluble or dispersible waste may be disposed of in the sanitary sewer only if the Authorized User was given approval by the RSC in the Radiation Work Permit. The Authorized User may dispose of licensed or license-exempt quantities of radioactive material in a hot sink under the following conditions:

- a. The material shall be readily soluble, or shall be readily dispersible biological material, in water;
- b. The quantity of licensed or other radioactive material that the licensee released into the sewer in one (1) month, divided by the average monthly volume of water released into the sewer by the licensee, shall not exceed the concentration in 902 KAR 100:019, Section 44, Table III. As a conservative measure the maximum allowed disposal activity will be restricted to 10% of the calculated limit. The RSO will post a document at each hot sink that indicates the maximum calculated activity of radioactive material that can be disposed in any given month or year.
- c. For the release of more than one (1) radionuclide, the following conditions shall be satisfied:
  - The licensee shall determine the fraction of the limit in 902 KAR 100:019, Section 44, Table III, represented by discharges into the sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide in 902 KAR 100:019, Section 44, Table III; and
  - The sum of the fractions for each radionuclide shall not exceed unity; and
  - The total quantity of licensed and other radioactive material that the licensee releases into the sewerage system in a year shall not exceed five (5) curies (185 GBq) of hydrogen-3, one (1) curie (37 GBq) of carbon-14, and one (1) curie of other radioactive materials combined.
- d. The solution disposed shall not exhibit characteristics of EPA-defined hazardous waste.
- e. Use only the sink designated in your Radiation Work Permit.
- f. Always keep amounts below the approved maximum.
- g. Dilute the waste several times and if possible, pour the waste directly into the drain. Flush the sink thoroughly afterward. Use the sink for disposal of uncontaminated waste also.
- h. If the drain in the sink becomes plugged or begins to leak, prevent others from using the sink and notify the RSO immediately.
- i. Make the appropriate entry in the Radioisotope Use/Disposal Record and the Hot Sink Disposal Record.

## **16.2 LIQUID RADIOACTIVE WASTE AND/OR LIQUID MIXED WASTE**

All liquid waste not approved for disposal in the sanitary sewer must be held in storage until proper disposal is arranged with a radioactive waste broker.

- a. Make every effort to avoid generating mixed waste. It is extremely expensive to dispose.
- b. Use a properly labeled polyethylene, Nalgene, or similar container that is chemically compatible with the waste. Carboys are good for storing moderate amounts of liquid waste. Be sure to keep the container tightly closed.
- c. Use separate storage containers for liquid radioactive waste and liquid mixed waste (i.e., waste that is also considered chemically hazardous according to the regulations of the US EPA).

- d. If there will be large volumes (> 10 gallons or 40 L) of liquid radioactive waste generated, call the RSO in advance to arrange for the acquisition of a DOT approved liquid waste drum or drums suitable for the volume of waste that will be generated.
- e. Empty all of the liquid into this container.
- f. Make the appropriate entry in the Radioisotope Use/Disposal Record.
- g. Keep the waste container in a secure place as designated in the Radiation Work Permit.
- h. Liquid waste containers must also be stored in a secondary containment.
- i. Close any full waste containers.
- j. Properly label the waste container with the radioactive waste tag pictured in Section 17.7 prior to RSO pickup. Contact the RSO to obtain waste tags.
- k. Contact the RSO when you need the waste removed from your work area.

### **16.3 SOLID RADIOACTIVE WASTE AND/OR SOLID MIXED WASTE**

A properly labeled waste container (typically a yellow bucket or garbage can) will be placed in your primary work areas for the disposal of dry (solid) radioactive waste or solid mixed waste. Solid waste is typically comprised of gloves, disposable lab coats, paper towels, glass or plastic labware, pipette tips, etc. No item of solid waste can contain more than 5 mL of liquid. The typical label used to identify a radioactive waste container is found in Section 16.7.

- a. Make every effort to avoid generating mixed waste. It is extremely expensive to dispose.
- b. If large volumes or masses of solid waste will be generated, contact the RSO in advance to arrange for the acquisition of a DOT approved solid waste drum (typically a 55-gallon steel drum).
- c. Put any powdered material in a plastic container and seal it prior to disposal.
- d. Put hypodermic needles, glass and other sharp objects inside shatterproof protection containers prior to disposal.
- e. Unless authorized by the RSO, do not put more than 25 pounds of material into a collection container.
- f. Close any full waste bags and properly label with the radioactive waste tag pictured in Section 16.7 prior to RSO pickup. Contact the RSO to obtain waste tags.
- g. Contact the RSO when you need the waste removed from your work area.

### **16.4 SEALED SOURCE DISPOSAL**

Sealed sources that are no longer needed must be disposed:

- a. by returning the source to the vendor
- b. through a properly licensed radioactive waste broker
- c. by license transfer to an authorized specific licensee

Contact the RSO when you have a sealed source that you wish to dispose.

## **16.5 DECAY-IN-STORAGE**

Departments possessing adequately shielded facilities may hold radioactive material with physical half-lives less than or equal to 120 days for decay-in-storage before disposal as ordinary trash, provided the following conditions are met:

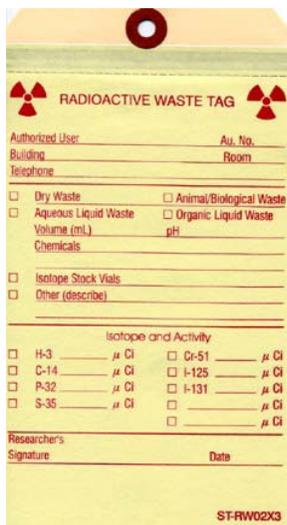
- a. When the waste bag in a waste storage container is full, it should be sealed and labeled with the appropriate identifying information. A radioactive waste tag attached to the bag with a twist tie is recommended for this and can be obtained from the Radiation Safety Officer. An image of the waste tag appears in Section 16.7.
- b. Liquid and solid waste held for decay-in-storage must be stored separately from non-decay in storage waste.
- c. All radiation labels are removed or obliterated
- d. The material, during storage, is stored in suitable, well-marked containers that provide adequate shielding for the emitted radiation.
- e. The radioactive material is held for decay a minimum of 10 half-lives
- f. Prior to disposal as ordinary trash, each container must be monitored as follows:
  - Check the radiation survey meter for proper operation
  - Survey the container in a low background area without shielding around the container
  - Monitor all surfaces of the container
  - Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e., surface readings are indistinguishable from background
- g. If the surveys indicate residual radioactivity, return the container to the decay-in-storage location for additional half-lives to allow further decay.

A record of the decay-in-storage disposal must be maintained that includes the date of the disposal, the date on which the radioactive material was placed in storage, the radionuclide(s) disposed, the model and serial number of the survey instrument used, the background radiation exposure rate, the radiation exposure rate measured at the surface of each waste container, and the name of the individual who performed the disposal.

## **16.6 DISPOSAL WITHOUT REGARD TO RADIOACTIVITY**

Liquid scintillation counting media containing 0.05  $\mu\text{Ci}$  or less of hydrogen-3 (tritium), carbon-14, or iodine-125 per gram of the medium may be disposed without regard to radioactivity. The liquid scintillation media cannot, however, be disposed down the sink or in the trash. Contact the RSO for guidance on submitting a regulated waste pickup request to the Department of Environment, Health & Safety.

## 16.7 RADIOACTIVE WASTE CONTAINER LABELS AND WASTE TAGS



**RADIOACTIVE WASTE TAG**

Authorized User: \_\_\_\_\_ Au. No. \_\_\_\_\_  
 Building: \_\_\_\_\_ Room: \_\_\_\_\_  
 Telephone: \_\_\_\_\_

Dry Waste  Animal/Biological Waste  
 Aqueous Liquid Waste  Organic Liquid Waste  
 Volume (mL) \_\_\_\_\_ pH \_\_\_\_\_  
 Chemicals: \_\_\_\_\_

Isotope Stock Vials  
 Other (describe): \_\_\_\_\_

Isotope and Activity

<input type="checkbox"/> H-3 _____ $\mu$ Ci	<input type="checkbox"/> Cr-51 _____ $\mu$ Ci
<input type="checkbox"/> C-14 _____ $\mu$ Ci	<input type="checkbox"/> I-125 _____ $\mu$ Ci
<input type="checkbox"/> P-32 _____ $\mu$ Ci	<input type="checkbox"/> I-131 _____ $\mu$ Ci
<input type="checkbox"/> S-35 _____ $\mu$ Ci	<input type="checkbox"/> _____ $\mu$ Ci
<input type="checkbox"/> _____ $\mu$ Ci	<input type="checkbox"/> _____ $\mu$ Ci

Researcher's  
 Signature: \_\_\_\_\_ Date: \_\_\_\_\_

SF-RW02X3



Typical Radioactive Waste Storage Container Label

Radioactive Waste Tag

## 17. DECOMMISSIONING RADIOACTIVE MATERIAL AREAS

Prior to the release of a radioactive material use/storage area for unrestricted use, that area must be decommissioned. Decommissioning initially involves the compilation of a historical site assessment that summarizes the radioisotope use/storage in a given area. In very simple cases historical documentation, such as contamination surveys, possession records, leak test records, etc. may be all that is required for the KY Radiation Health Branch to recognize and approve that a given location is decommissioned. What is more often needed in addition to the historical site assessment and documentation is a final status survey that confirms residual radioactivity (if any) will not cause any individual to receive more than 25 mrem/year from that residual activity. This is the stated dose-based release criterion per 902 KAR 100:042. There may be simple final status surveys that can be handled by the RSO and the Authorized User. In other cases, the RSO will obtain a quotation from a vendor to conduct a MARSSIM-compliant survey and provide a final status report. It is the Authorized User's responsibility to request the proper removal of all radioactive sources and radioactive waste prior to decommissioning. Radiation postings, warning signs, etc. shall not be removed prior to the completion of the decommissioning process. Decommissioning is considered complete only after the final status survey report has been submitted to, and approved by, the KY Radiation Health Branch via a license amendment request. Please contact the RSO if you have a radioactive materials use area that you wish to release to unrestricted use.

## **APPENDIX A: BYLAWS OF THE WESTERN KENTUCKY UNIVERSITY RADIATION SAFETY COMMITTEE**

### **OBJECTIVE**

The Western Kentucky University (WKU) Radiation Safety Committee (RSC) has the authority and responsibility delegated from the President of WKU for developing and maintaining a radiation safety program for the University to ensure the safe handling of ionizing radiation in the University's instructional, research, and operational programs. It is the first duty of the Committee to ensure the safe use of any source of ionizing radiation employed within the jurisdiction of the President of Western Kentucky University. It is the second duty of the Committee to facilitate the use of ionizing radiation and to provide advice and counsel as requested. Among its duties, it shall recommend University policy with respect to radiation safety; establish standards and regulations for radiation safety at all University-controlled facilities; review and record safety evaluations of all activities involving ionizing radiation at University-controlled facilities and authorize those found to be acceptable; review annually the operations and procedures of Radiation Safety; and act as the statutory radiation safety committee required by the University's state and federal licenses pertaining to radioactive materials and radiation generators.

### **ARTICLE I. MEMBERS SECTION**

Section 1.01 The membership of this Committee shall consist of not less than five, or more than ten members, and shall include the University's Radiation Safety Officer.

Section 1.02 All members are appointed by the Chair of the Committee.

Section 1.03 If a vacancy occurs in the Committee, the Committee members shall nominate candidates to fill the position.

Section 1.04 Members shall be appointed on the basis of knowledge of the principles and practices of the control of hazards from the use of radiation, experience in the use of radioisotopes and/or radiation producing machines, and on knowledge of environment and worker health and safety. Committee membership shall reflect the diversity of the scientific disciplines using ionizing radiation on campus, overall health and safety on campus, and campus management.

Section 1.05 Members of the Committee or Subcommittee(s) that are not ex-officio members have the right to vote on issues at hand. Members should exempt themselves from voting if the issue at hand has specific influence over the area they represent to avoid bias.

### **ARTICLE II. OFFICERS**

Section 2.01 The Officers of the Committee shall be the Chair, Secretary, and Radiation Safety Officer. These officers shall perform the duties prescribed by these bylaws and by the parliamentary authority adopted by the Committee.

Section 2.02 The Chair shall be an administrator at the Dean level or greater.

Section 2.03 The Secretary shall be appointed by the Committee.

Section 2.04 The Radiation Safety Officer is an ex-officio member of the Committee and standing officer of the Committee. The Radiation Safety Officer will officiate the Committee meetings in the absence of the Chair.

### **ARTICLE III. THE EXECUTIVE BOARD**

Section 3.01 The Chair and the RSO shall constitute the Executive Board.

Section 3.02 The Executive Board shall have general supervision of the affairs of the Committee between its business meetings, fix the hour and place of meetings, make recommendations to the Committee, and shall perform such other duties as specified in these bylaws. The Board shall be subject to the orders of the Committee, and none of its acts shall conflict with action taken by the Committee.

Section 3.03 Meetings of the Board shall be held as needed.

### **ARTICLE IV. MEETINGS**

Section 4.01 There shall be at least one regular meeting each year.

Section 4.02 Special meetings may be called by the Chair or Secretary, or upon the written request of three members of the Committee. Except in cases of emergency, at least three days' notice shall be given.

Section 4.03 In an emergency or for urgent matters between meetings, meetings via the telephone or via Email are permitted. If action on such a basis is necessary, it must be ratified at the next regular or special meeting.

Section 4.04 A simple majority of the total voting membership shall constitute a quorum.

Section 4.05 Approvals by the Committee are signified by the receipt of a simple majority vote of approval by the eligible voting members of the Committee.

### **ARTICLE V. SUBCOMMITTEES**

Subcommittees, either standing or special, or task force(s), shall be appointed by the Chair as the Committee shall from time to time deem necessary to carry on the work of the Committee. The Chair shall be ex-officio a member of all subcommittees and task forces.

### **ARTICLE VI. SPECIFIC ADMINISTRATIVE PROCEDURES**

The Committee shall establish written procedures for:

Section 6.01 Possession and use of all sources of ionizing radiation at University-controlled facilities.

Section 6.02 Submission and processing of requests to authorize such possessions and uses. After considering the evaluation and advice of the Radiation Safety Officer, the Committee shall review and grant or deny permission for, or disapproval of, the use of radioactive materials or machine sources of ionizing radiation within the University; approve and disapprove all specific users of radioactive materials and machine sources of ionizing radiation with the University; prescribe any special conditions that will be required during a proposed use of ionizing radiation, such as minimum level of training and

experience of user, special facilities, unusual monitoring requirements, etc.; and recommend or require remedial action to correct safety, regulatory, or university policy infractions. Reviews and approvals may be made by the Executive Board in accordance with Article IV, Section 2.

Section 6.03 Annual reviews of Radiation Safety operations and procedures. The Committee shall, with the assistance of the Radiation Safety Officer, formulate and review the University training programs for the safe use of radionuclides and machine sources of ionizing radiation. The Committee shall inform the Kentucky Cabinet for Health Services of any changes in the Committee membership and practices; shall ensure the maintenance of written records of receipts, transfers, and disposal of all radioactive materials in the University and the maintenance of an inventory of the total quantity of each radionuclide possessed by the University.

Section 6.04 Annual reports. The Committee shall require and review annual reports for the period from 1 January through 31 December by the Radiation Safety Officer, specifically including the following:

- (a) a report on compliance with respect to the health and safety of workers and the public in the use of ionizing radiation,
- (b) a summary report on personnel exposure to ionizing radiation,
- (c) a summary report on radioactive waste disposal,
- (d) a summary report on radiation safety surveys, and
- (e) other items of significance to the radiation safety program.

Section 6.05 Periodic reviews of all radiation safety standards and procedures, and institution of changes whenever appropriate. The Committee shall require the preparation, distribution, and periodic maintenance of guides and the Western Kentucky University Radiation Safety Manual. The Committee shall require the Radiation Safety Officer to report conditions not in compliance with license requirements. The report will include a description of the RSO suggestions on how the deficiencies can be corrected, or how they have been corrected. The Committee shall signify approval in writing.

Section 6.06 The Committee shall establish additional internal procedures as it deems desirable.

## **ARTICLE VII. PARLIAMENTARY AUTHORITY**

The rules contained in Roberts Rules of Order shall govern the Committee in all cases to which they are applicable and in which they are not inconsistent with these bylaws and applicable to this organization.

## **ARTICLE VIII. AMENDMENT OF BYLAWS**

These bylaws may be amended at any meeting of the Committee by a two-thirds vote, provided that the amendment has been submitted in writing to the entire membership at least two weeks prior to the vote.

## APPENDIX B – PORTABLE X-RAY FLUORESCENCE (XRF) ANALYZERS CONTAINING SEALED SOURCES

The Niton Portable XRF gauge contains a sealed source and has requirements additional to those addressed in other sections and appendices of this manual. The additional requirements are detailed in this appendix.

### LICENSED MATERIAL AND USE RADIOACTIVE MATERIAL

Table B-1 lists specifics of portable and fixed gauges currently possessed by WKU.

Table B-1: Licensed Material and Current Use of Radioactive Material in Gauges

	Portable XRF
<b>(a) Radioisotope used in gauge</b>	<sup>109</sup> Cd
<b>(b) Manufacturer/Model # of each sealed source</b>	XLP303A, SN 24606
<b>(c) Activity of each sealed source</b>	No single source to exceed 50 mCi
<b>(d) Manufacturer/Model # of gauge used</b>	Niton Corporation XLP 300
<b>(e) Commitment to limit source/device combinations</b>	*
<b>(f) Purpose(s) of gauging device</b>	Portable Gauge. Measure lead in paint. Measure trace material content in soil, filters, dust wipes, etc.

\*Western Kentucky University commits to limit the number of source/device combinations such that the quantities of radioactive material that would require financial assurance for decommissioning would not be exceeded. These limits are defined in 902 KAR 100:042.

### PORTABLE NITON XRF GAUGE

#### Individual Users

Individuals who will use the Niton XRF independently must be approved as a licensed Authorized User to do so by the WKU Radiation Safety Committee. The WKU Radiation Safety Officer maintains a list of licensed radioactive material users.

#### Supervision Requirements

The Niton XRF will be used by or under the supervision of an Authorized User. Supervision means that an Authorized User must be on site. For example, when the device is used on the WKU campus (including South Campus, the Center for Research & Development, and the WKU Farm), supervision will be considered adequate if the Authorized User is informed prior to use and is present and reachable somewhere on campus during use. If the Niton XRF is to be used at a temporary job site off the WKU campus locations listed above, the Authorized User must be at the temporary job site with the user.

**Radiation Detection Instruments**

Routine use of a Niton XRF does not require the possession or use of radiation survey instrumentation. Maintenance and repair operations are not considered to be routine use.

**Personnel Monitoring**

Personal dosimetry is not required to be worn by personnel performing routine operation of the Niton XRF. Routine operation does not include the repair or maintenance of the gauge. Dosimetry is available upon request regardless of requirement.

**Niton XRF Use Log**

A use log shall be maintained by the authorized user/possessor of the Niton XRF. This log will provide documentation of who actually used the gauge and should include the name of the user, dosimeter number (if applicable), date gauge removed from storage, serial number of gauge, use location and date returned to storage. Records of utilization logs must be maintained for five (5) years. A copy of this utilization log can be found at the end of this Appendix.

**Niton XRF Use Locations**

The Niton XRF will be used and stored at, and transported to and from temporary job sites, in areas not under exclusive federal jurisdiction, anywhere in the Commonwealth of Kentucky where the Cabinet maintains jurisdiction for regulating the use of radioactive material. The temporary job sites include classrooms where the use of the Niton XRF is included as part of the coursework. When the XRF is not in storage it shall be under the constant surveillance and immediate control of the user.

**Operating and Emergency Procedures**

Operating and emergency procedures must be written and provided to each Niton XRF user before beginning use. The gauge user must ensure that a copy of these procedures is present at each temporary job site. A copy of the Operating and Emergency Procedures appears at the end of this appendix.

**Gauge Repair and Maintenance**

Repair and maintenance of the Niton XRF that involves removing the source from the gauge or taking the source out of the safe, shielded position shall only be done by the vendor, **Thermo Niton**. Any maintenance, such as cleaning of the gauge housing, shall be performed with the source in the safe, shielded position.

**Transportation of Portable Gauges**

Transportation activities must be carried out in accordance with the requirements of 902 KAR 100:070 and U.S. Department of Transportation (DOT) regulations.

The Niton XRF with its <sup>109</sup>Cd source packaged in the carrying case provided by Niton qualifies as a DOT excepted package for radioactive instruments and articles. As such it is excepted from the specification packaging, marking, labeling, shipping paper and certification required for non-excepted packages. The only DOT- required marking for this package is that it be clearly labeled "UN2911."

During transportation, the Niton XRF must be fully secured in the vehicle and away from the passenger area.

Users that will drive a vehicle containing the Niton XRF must have documented current (within the last three years) DOT HazMat training.

### **Storage Facilities**

When not in actual use by the individuals authorized by the license, the Niton XRF shall be stored in its secured case that is kept in a secured cabinet in the basement of the Department of Environmental Health & Safety. The XRF shall be stored in such a way that will prevent access by unauthorized persons and will not be stored in residential quarters. If the XRF is kept at a storage location overnight, it shall be kept in its secured case in a locked vehicle or in a secure, locked room provided by the site owner. When the XRF is not in storage it will be under the constant surveillance and immediate control of the user.

### **Posting of Documents, Notices and Forms**

In accordance with 902 KAR 100:165, Section 2, all required documents, notices, and forms shall be posted in order to be readily observable by employees. The items are posted on the storage cabinet in the basement of WKU Environmental Health & Safety. These postings do not apply to temporary overnight storage locations.

### **Waste Disposal**

Disposal of the sealed source contained in the portable XRF will be accomplished by returning the XRF to the original vendor.

## NITON PORTABLE XRF

### STANDARD OPERATING AND EMERGENCY PROCEDURES

#### Operating Procedures

1. Before removing the device from its place of storage, check to make sure that the source is in its shielded, locked position. Check the transport case to ensure required labels and markings are legible, and that the lock is operable. Lock the transport case.
2. Sign the device out in a log book, stating the dates of use, names of the authorized users who will be responsible for the gauge, and the temporary job sites where the gauge will be used.
3. Never leave the gauge unattended while in your custody.
4. Follow all applicable Department of Transportation (DOT) requirements when transporting the gauge (block and brace the device in the rear of the transport vehicle, away from passengers; carry shipping papers (if applicable) and emergency procedures in the passenger compartment, etc).
5. Refer to the Niton User's Guide for instructions on the proper operation of the device.
6. Do not expose your fingers, hands, or any part of your body to the radiation beam. Make sure the source is locked in the shielded position after each measurement is made.
7. Always wear your assigned dosimetry when using the device (if applicable). Never wear another person's dosimetry. Never store your dosimetry near the device.
8. Always keep unauthorized persons away from the area where the device is being used.
9. Always maintain constant surveillance and immediate control of the device when it is not locked in storage.
10. When the device is not in use at temporary job sites, place the device in a secured storage location (e.g., locked in the trunk of a car or locked in a storage shed).
11. Return the device to its proper storage location at the end of the work shift.
12. When the device is returned to storage, indicate so on the source log.

**Emergency Procedures**

If the source cannot be returned to the shielded condition (i.e., the shutter will not close, for example, as a result of being damaged) or if any other emergency or unusual situation arises (e.g., the device is struck or otherwise damaged, dropped, or if the transport vehicle is involved in an accident which may involve damage to the device):

1. Immediately secure the area around the device;
2. Prevent unauthorized personnel from entering the secured area.

***Note: Emergency rescue, lifesaving and first aid efforts should not be delayed or hampered.***

3. If any heavy equipment is involved (e.g., device run over by vehicle), detain the equipment until it is determined that there is no contamination present;
4. Notify licensee management of the situation, calling company personnel in the order listed below:

NAME	WORK PHONE NUMBER	MOBILE PHONE NUMBER
Sarah Grant, RSO	270-745-3597	270-535-4822

5. If the RSO listed in item 4 above cannot be contacted, call Thermo Niton at:  
Niton 800-875-1578 Mon-Sat; 617-861-1155 Sun & Nights
6. Follow the directions provided by the person contacted in step 4.
7. Notify Cabinet for Health and Family Services, Radiation Health Branch at (502) 564-3700 during normal working hours or (800) 255-2587 other hours; if required.

REMINDER TO LICENSEE MANAGEMENT:

- a) Arrange for a survey to be conducted as soon as possible by a knowledgeable person using appropriate radiation detection instrumentation. (This person could be a licensee employee using a survey meter located at the jobsite or a consultant.)
- b) Make necessary notifications to local authorities as well as to the Cabinet as required. Cabinet notification is required when devices containing radioactive material are lost or stolen, or when devices are damaged or involved in incidents that result in doses in excess of 902 KAR 100:019 limits.
- c) Timelines of reports to the Cabinet need to be considered.
- d) Reporting requirements are found in 902 KAR 100:019 Sections 38, 39 and 40 and 902 KAR 100:040, Section 15.



## APPENDIX C – AUTHORIZED USER APPLICATION

### STATEMENT OF TRAINING AND EXPERIENCE

(Use supplemental sheets if necessary)

AUTHORIZED USER APPLICANT NAME: \_\_\_\_\_

TITLE/POSITION: \_\_\_\_\_

HIGHEST ACADEMIC DEGREE: \_\_\_\_\_

DEPARTMENT: \_\_\_\_\_

TELEPHONE: \_\_\_\_\_

E-MAIL: \_\_\_\_\_

DATE PREPARED: \_\_\_\_\_

An individual who is planning to work with radioactive materials or equipment containing radioactive materials must satisfy the Radiation Safety Committee that he/she is qualified by virtue of training and experience to handle such materials and equipment safely. The information requested below is reviewed by the Committee when considering your application.

TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES				
TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	FORMAL COURSE	ON THE JOB
Principles and practices of radiation protection			<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO
Radioactivity measurement standardization and monitoring techniques and instruments			<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO
Mathematics and calculations basic to the use and measurement of radioactivity			<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO
Biological effects of radiation			<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO

PREVIOUS EXPERIENCE WITH RADIATION (Actual use of radioisotopes)					
ISOTOPE	MAXIMUM AMOUNT	ORGANIZATION WHERE EXPERIENCE WAS GAINED	DATES OF USE	TYPE OF USE	SUPERVISED or UNSUPERVISED USE?

Applicant's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
(Radiation Safety Officer)

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
(Radiation Safety Committee Chair)

## APPENDIX D – RADIATION WORK PERMIT

<b>RSO Use Only</b>
RWP No.: _____

**INSTRUCTIONS:**

This form is to be completed by the AU and approved by the RSO and RSC prior to any work performed with radioactive materials. The AU should submit the completed form to the RSO via Campus Mail addressed to Environmental Health & Safety, 1716 Park Street.

PRIMARY AUTHORIZED USER: \_\_\_\_\_  
 TITLE/POSITION: \_\_\_\_\_  
 DEPARTMENT: \_\_\_\_\_  
 TELEPHONE: \_\_\_\_\_  
 E-MAIL: \_\_\_\_\_  
 DATE PREPARED: \_\_\_\_\_

List all the isotopes and physical forms for which the permit is being sought (use supplemental sheets if necessary). If your permit is for a sealed source, please contact the vendor to obtain a copy of the Sealed Source and Device Registry certificate and attach it to this RWP.

Isotope*	Maximum activity that you are requesting to be in your possession at any one time, including waste and stores	Physical Form	Source Shall Be		
			Sealed	Open	Part of Device
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

This application is (please check all that apply):

- An initial application for this isotope
- A request for a change of approved location for an existing RWP
- A request for an increase of an isotope approved in an existing RWP
- A request to add an AU to an existing RWP
- A request to change the contact information for the primary AU in an existing RWP
- A request to use radioactive material away from WKU under the condition of reciprocity
- Other: \_\_\_\_\_

Please answer the following questions (use another sheet of paper, if additional space is required).

1. Explain briefly the intended use of the radioactive materials/equipment.
  
2. List the building(s) and room(s) where the isotope(s) will be stored and/or used. Attach a scale floor plan showing these locations and the adjacent non-radiation use areas.

3. Is (are) this (these) location(s) currently an approved radioactive materials use/storage area?  
 Yes  No If yes, explain.
4. List the RWP No. for any other approved Radiation Work Permit you have been issued.
5. Describe the experiment in general terms. Indicate typical activities of radioactive materials to be used, and duration/frequency of use. Describe physical/chemical manipulations or activations intended, if applicable. If any activation products will result from the use of the indicated radioactive material, provide detailed information.
6. Will this material be used by persons other than you?  Yes  No  
If yes, provide information to identify these persons, their qualifications, and indicate how you intend to ensure that they receive adequate supervision.
7. Are you familiar with the provisions and regulations of the following:
- |  |                              |                             |
|--|------------------------------|-----------------------------|
| Standards for Protection Against Radiation, 902 KAR 100:019? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| WKU Radioactive Material License?                            | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| WKU Radioactive Materials Safety Manual                      | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
8. If there is (or shall be) possession of survey and monitoring equipment, complete the Survey and Monitoring Equipment Form in Item 20. Itemize specific items owned and/or those which you plan to obtain if this application is approved.
- There is (or shall be) survey/monitoring equipment. A Survey and Monitoring Equipment Form is completed in Item 20. Include any additional information that is important regarding survey/monitoring equipment.
- Survey/monitoring equipment is not required (state why).
9. Outline the specific plans for the transportation, order, receipt, use, and storage of radioactive material(s). Specify the records that will be kept.
10. Outline the specific plans for storage and disposal of radioactive waste (if any). Specify the records that will be kept.
11. Describe arrangements that have been made with the Radiation Safety Officer with respect to personnel monitoring requirements.
- There is (or shall be) personnel monitoring. A Dosimetry Form is completed in Item 21. Include any additional information that is important regarding personnel monitoring.

Personnel monitoring is not needed (state why).

12. Outline the plans for the orientation of assistants, staff, students, or visitors with respect to radiological safety in general.

13. Describe any storage facility(ies) for the radioactive material(s) and outline plans to secure isotope(s) and contaminated waste from use or possession by unauthorized personnel, or to prevent accidental loss.

14. What facilities and protective equipment are available? (Hoods, absorbent paper, labels, tags, shielding, etc.)

15. Describe the precautions that will be taken to test for leakage and/or contamination upon receipt of these materials.

16. What measures will be taken to prevent, detect, and handle a “spill” or “leak”?

17. (For existing AUs only) Provide any information on training or experience not listed on your AU application that is relevant to this RWP.

18. Please provide any other information that might be helpful to the Radiation Safety Officer and the Radiation Safety Committee.

19. Radioactive Materials Information Form

Isotope	Activity	Identifying Information		Half-Life	Radiation Types ( $\alpha$ , $\beta$ , $\gamma$ , x, n)	Isotope On WKU License?	*Copy of SSDR Attached?
		Manufacturer	Model				

\*Note: If your application is for a sealed source, obtain a copy of the Sealed Source and Device Registry certificate from the vendor for the item you are purchasing and attach it to this application.

20. Survey and Monitoring Form

Radiation Survey Meter(s)			
Manufacturer	Meter Model No.	Probe Model No.	Radiation(s) Detected

21. Dosimetry Form

Personal Dosimetry			
Dosimetry Vendor	Dosimeter Type	Radiation(s) Detected	Exchange Frequency

Check here if personal dosimetry is not required

Visitor/Observer Dosimetry		
Manufacturer	Model	Radiation(s) Detected

Check here if visitor/observer dosimetry is not required

**RADIATION WORK PERMIT CERTIFICATION AND APPROVAL**

I certify that the work performed with the materials requested in this application will be done in accordance with the rules and regulations contained in 902 KAR 100, WKU’s Radioactive Material License, and the WKU Radioactive Material Safety Manual.

Applicant’s Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
(Radiation Safety Officer)

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
(Radiation Safety Committee Chair)

## APPENDIX E – RADIATION WORK PERMIT AMENDMENT

RSO Use Only
RWP No.: _____

**INSTRUCTIONS:**

This form is to be completed by the AU and approved by the RSO and RSC prior to any work performed with radioactive materials. The AU should submit the completed form to the RSO via Campus Mail addressed to Environmental Health & Safety, 1716 Park Street.

PRIMARY AUTHORIZED USER: \_\_\_\_\_  
 TITLE/POSITION: \_\_\_\_\_  
 DEPARTMENT: \_\_\_\_\_  
 TELEPHONE: \_\_\_\_\_  
 E-MAIL: \_\_\_\_\_  
 DATE PREPARED: \_\_\_\_\_

1. For which RWP No. are you requesting this amendment?
2. Please describe the changes you are requesting to the RWP No. indicated in Item 1.

### RADIATION WORK PERMIT AMENDMENT CERTIFICATION AND APPROVAL

I certify that the work performed with the materials requested in this application will be done in accordance with the rules and regulations contained in 902 KAR 100, WKU’s Radioactive Material License, and the WKU Radioactive Material Safety Manual.

Applicant’s Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
 (Radiation Safety Officer)

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
 (Radiation Safety Committee Chair)

## APPENDIX F – RADIOACTIVE MATERIAL ACQUISITION PRE-APPROVAL FORM

**INSTRUCTIONS:** PLEASE FILL OUT THIS FORM AND SUBMIT IT TO THE RADIATION SAFETY OFFICER VIA EMAIL, [SARAH.GRANT@WKU.EDU](mailto:SARAH.GRANT@WKU.EDU) , OR CAMPUS MAIL ADDRESSED TO ENVIRONMENTAL HEALTH & SAFETY, PARK STREET HOUSE.

<b>I. Authorized User Information</b>			
Name:	Professional Title:		
Department:	Building:		
Room Number:	Phone Number:		
RWP No.:			
<b>II. Radioactive Material Information</b>			
Isotope:	Supplier/Manufacturer:		
Activity:	Catalog Number:		
Chemical/Physical Form:	Expected Delivery Date:		
Comments:			
<b>III. Activity Type</b>			
<input type="checkbox"/>	New Purchase: By University Funds <input type="checkbox"/> or Grant Funds <input type="checkbox"/> <b>Index #:</b>		
<input type="checkbox"/>	Loan from non-WKU Organization		
<input type="checkbox"/>	Donation/Gift		
<b>IV. Signatures</b>			
I certify that this radioactive material shall be ordered and received in accordance with 902 KAR 100, the WKU Radioactive Material License, and the WKU Radioactive Material Safety Manual.			
Requestor Signature:		Date:	
I have reviewed the above information, and confirm that the applicant is authorized to receive this radioactive material and that acquiring this material will not violate the WKU Radioactive Material License. I also concur that the vendor has been given a current copy of our Radioactive Materials License.			
Radiation Safety Officer, Sarah A. Grant			Date

## APPENDIX G - RADIOACTIVE SHIPMENT RECEIPT REPORT

1. P.O. No.: \_\_\_\_\_ Date/Time: \_\_\_\_\_  
 Surveyor: \_\_\_\_\_ Item/Isotope Received: \_\_\_\_\_  
 RWP No.: \_\_\_\_\_

2. Condition of package  
 OK  Punctured  Wet  Crushed  Other: \_\_\_\_\_

3. Radiation units of label: \_\_\_\_\_ mR/hr;  No label

4. Do packing slip and vial contents agree?  
 a. Radionuclide  yes  no, difference \_\_\_\_\_  
 b. Activity  yes  no, difference \_\_\_\_\_  
 c. Chemical Form  yes  no, difference \_\_\_\_\_

5. Greater than Type A activity?  
 Yes  No  
 If Yes, continue to 7. If no, continue to 6.

6. Liquid radioisotope?  
 Yes  No  
 If Yes, continue to 7. If no, continue to 10 and provide your signature and the date.

7. Wipe results from liquid sources and sealed sources with no wipe test information:  
 a. Outer Package Surface: \_\_\_\_\_ CPM = \_\_\_\_\_  DPM  or  $\mu\text{Ci}$   
 b. Final Source Container: \_\_\_\_\_ CPM = \_\_\_\_\_  DPM  or  $\mu\text{Ci}$   
 Note:  $(\text{CPM})/(\text{efficiency}) = \text{DPM}$

8. Survey Information  
 Model: \_\_\_\_\_ Background: \_\_\_\_\_  
 Serial Number: \_\_\_\_\_ 3 ft. from pkg. Surface: \_\_\_\_\_  
 Date of Last Calibration: \_\_\_\_\_ Package Surface: \_\_\_\_\_

9. Disposition of package after \_\_\_\_\_  
 inspection

10. If department/carrier notification required, give time, date, and persons notified.  
 Time: \_\_\_\_\_ Date: \_\_\_\_\_ Person(s) notified: \_\_\_\_\_

\_\_\_\_\_  
 Signature

\_\_\_\_\_  
 Date





## APPENDIX J - AVAILABLE SURVEY INSTRUMENTATION

Manufacturer	Model	Type	Serial #	Radiation Detected	Range
Ludlum	14C, 44-9	GM Pancake	169346, PR173886	$\alpha, \beta-\gamma, x$	0-6.6 kcpm, 0-2 mR/hr; scale multipliers of 0.1, 1, 10, 100, 1000
Victoreen	190AC, RP-N	Proportional	267, 161	$\eta$	0 $\mu$ rem/hr -75 rem/hr
Ludlum	3, 44-7	GM End-Window	60746, PR349030	$\alpha, \beta-\gamma$	0-5k cpm, scale multipliers of 0.1, 1, 10, 100
Eberline	E600, NRD-1	Proportional	1768, 722253	$\eta$	1 – 10,000 mrem/hr
Ludlum	3, 44-9	GM Pancake	182338, PR187671	$\alpha, \beta-\gamma, x$	0-6.6 kcpm, 0-2 mR/hr; scale multipliers of 0.1, 1, 10, 100
International Medcom	Radalert Inspector	GM Pancake	22750	$\alpha, \beta-\gamma, x$	0.001 – 100.00 mR/hr 0 – 350,000 cpm
International Medcom	Radalert Inspector	GM Pancake	22749	$\alpha, \beta-\gamma, x$	0.001 – 100.00 mR/hr 0 – 350,000 cpm



# APPENDIX K - RADIATION CONTAMINATION SURVEY FORM

LOCATION: \_\_\_\_\_

INCLUDE LABORATORY FLOOR PLAN

Date \_\_\_\_\_  
 Survey Instrument Model \_\_\_\_\_  
 Last Calibration Date \_\_\_\_\_  
 Instrument Battery OK (if applicable)?  Yes  No  N/A  
 Survey Type:  Daily  Weekly  Monthly

Name of Surveyor \_\_\_\_\_  
 Survey Instrument Serial Number \_\_\_\_\_  
 Verified Operation of Instrument?  Yes  No  
 Isotope \_\_\_\_\_

Survey Area (Number floor plan & describe below)	Survey Instrument Reading (CPM)	Survey Instrument Background (CPM)	Survey Result (Net CPM)	Instrument Efficiency for Isotope (%)	Survey Result (DPM)	Area Surveyed (cm <sup>2</sup> )	Survey Result (DPM/100 cm <sup>2</sup> )	Comments

## APPENDIX L - ON-CAMPUS TRANSFER OF RADIOACTIVE MATERIAL FORM

SOURCE INFORMATION	
Date	
Isotope	
Source Description	
Serial Number(s)	
Activity	
Activity Reference Date	
Current Location	
CURRENT USER INFORMATION	
Current Authorized User	
Current Radiation Work Permit No.	
Additional Information	
RECIPIENT INFORMATION	
Recipient Authorized User	
Intended Source Location	
Recipient Radiation Work Permit (RWP) No.	
SIGNATURES	
Authorized User: _____	Date: _____
Recipient Authorized User: _____	Date: _____
Radiation Safety Officer: _____	Date: _____

## APPENDIX M – OFF-CAMPUS TRANSFER OF RADIOACTIVE MATERIAL FORM

<b>SOURCE INFORMATION</b>	
Date	
Isotope	
Source Description	
Serial Number(s)	
Activity	
Activity Reference Date	
Current Location	
Current Authorized User	
Expected Transfer Date	
Expected Return Date	
Additional Information	
<b>RECIPIENT INFORMATION</b>	
Organization Name	
Organization Address	
Organization Contact	
Contact Telephone	
Contact E-mail	
<b>SIGNATURES</b>	
Authorized User: _____	Date: _____
Radiation Safety Officer: _____	Date: _____
<b>RSO USE ONLY</b>	
Organization Type: <input type="checkbox"/> Original Vendor <input type="checkbox"/> Non-vendor Copy of non-vendor radioactive material license obtained? <input type="checkbox"/> Yes <input type="checkbox"/> No Letter received from non-vendor for transfer of material to its radioactive material license? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Date source returned to WKU:	
Notes:	

## APPENDIX N - DECLARATION OF PREGNANCY

Please find in the following pages a copy of the [USNRC Regulatory Guide](#) concerning prenatal radiation exposure. Contact the Radiation Safety Officer if you have any questions or wish to know the citations for the Kentucky equivalent regulations to those 10 CFR federal regulations quoted in the guide.

### **NRC REGULATORY GUIDE 8.13 INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE**

Revision 3 June 1999

#### **A. INTRODUCTION**

The Code of Federal Regulations in 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," in Section 19.12, "Instructions to Workers," requires instruction in "the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed." The instructions must be "commensurate with potential radiological health protection problems present in the work place."

The Nuclear Regulatory Commission's (NRC's) regulations on radiation protection are specified in 10 CFR Part 20, "Standards for Protection Against Radiation"; and Section 20.1208, "Dose to an Embryo/Fetus," requires licensees to "ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv)." Section 20.1208 also requires licensees to "make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman." A declared pregnant woman is defined in 10 CFR 20.1003 as a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

This regulatory guide is intended to provide information to pregnant women, and other personnel, to help them make decisions regarding radiation exposure during pregnancy. This Regulatory Guide 8.13 supplements Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure" (Ref. 1), which contains a broad discussion of the risks from exposure to ionizing radiation.

Other sections of the NRC's regulations also specify requirements for monitoring external and internal occupational dose to a declared pregnant woman. In 10 CFR 20.1502, "Conditions Requiring Individual Monitoring of External and Internal Occupational Dose," licensees are required to monitor the occupational dose to a declared pregnant woman, using an individual monitoring device, if it is likely that the declared pregnant woman will receive, from external sources, a deep dose equivalent in excess of 0.1 rem (1 mSv). According to Paragraph (e) of 10 CFR 20.2106, "Records of Individual Monitoring Results," the licensee must maintain records of dose to an embryo/fetus if monitoring was required, and the records of dose to the embryo/fetus must be kept with the records of dose to the declared pregnant woman. The declaration of pregnancy must be kept on file, but may be maintained separately from the dose records. The licensee must retain the required form or record until the Commission terminates each pertinent license requiring the record.

The information collections in this regulatory guide are covered by the requirements of 10 CFR Parts 19 or 20, which were approved by the Office of Management and Budget, approval numbers 3150-0044 and 3150-0014, respectively. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

## **B. DISCUSSION**

As discussed in Regulatory Guide 8.29 (Ref. 1), exposure to any level of radiation is assumed to carry with it a certain amount of risk. In the absence of scientific certainty regarding the relationship between low dose exposure and health effects, and as a conservative assumption for radiation protection purposes, the scientific community generally assumes that any exposure to ionizing radiation may cause undesirable biological effects and that the likelihood of these effects increases as the dose increases. At the occupational dose limit for the whole body of 5 rem (50 mSv) per year, the risk is believed to be very low.

The magnitude of risk of childhood cancer following in utero exposure is uncertain in that both negative and positive studies have been reported. The data from these studies "are consistent with a lifetime cancer risk resulting from exposure during gestation which is two to three times that for the adult" (NCRP Report No. 116, Ref. 2). The NRC has reviewed the available scientific literature and has concluded that the 0.5 rem (5 mSv) limit specified in 10 CFR 20.1208 provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers associated with radiation exposure during pregnancy.

In order for a pregnant worker to take advantage of the lower exposure limit and dose monitoring provisions specified in 10 CFR Part 20, the woman must declare her pregnancy in writing to the licensee. A form letter for declaring pregnancy is provided in this guide or the licensee may use its own form letter for declaring pregnancy. A separate written declaration should be submitted for each pregnancy.

## **C. REGULATORY POSITION**

### **1. Who Should Receive Instruction**

Female workers who require training under 10 CFR 19.12 should be provided with the information contained in this guide. In addition to the information contained in Regulatory Guide 8.29 (Ref. 1), this information may be included as part of the training required under 10 CFR 19.12.

### **2. Providing Instruction**

The occupational worker may be given a copy of this guide with its Appendix, an explanation of the contents of the guide, and an opportunity to ask questions and request additional information. The information in this guide and Appendix should also be provided to any worker or supervisor who may be affected by a declaration of pregnancy or who may have to take some action in response to such a declaration.

Classroom instruction may supplement the written information. If the licensee provides classroom instruction, the instructor should have some knowledge of the biological effects of radiation to be able to answer questions that may go beyond the information provided in this guide. Videotaped presentations may be used for classroom instruction. Regardless of whether the licensee provides

classroom training, the licensee should give workers the opportunity to ask questions about information contained in this Regulatory Guide 8.13. The licensee may take credit for instruction that the worker has received within the past year at other licensed facilities or in other courses or training.

### 3. Licensee's Policy on Declared Pregnant Women

The instruction provided should describe the licensee's specific policy on declared pregnant women, including how those policies may affect a woman's work situation. In particular, the instruction should include a description of the licensee's policies, if any, that may affect the declared pregnant woman's work situation after she has filed a written declaration of pregnancy consistent with 10 CFR 20.1208.

The instruction should also identify who to contact for additional information as well as identify who should receive the written declaration of pregnancy. The recipient of the woman's declaration may be identified by name (e.g., John Smith), position (e.g., immediate supervisor, the radiation safety officer), or department (e.g., the personnel department).

### 4. Duration of Lower Dose Limits for the Embryo/Fetus

The lower dose limit for the embryo/fetus should remain in effect until the woman withdraws the declaration in writing or the woman is no longer pregnant. If a declaration of pregnancy is withdrawn, the dose limit for the embryo/fetus would apply only to the time from the estimated date of conception until the time the declaration is withdrawn. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

### 5. Substantial Variations Above a Uniform Monthly Dose Rate

According to 10 CFR 20.1208(b), "The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section," that is, 0.5 rem (5 mSv) to the embryo/fetus. The National Council on Radiation Protection and Measurements (NCRP) recommends a monthly equivalent dose limit of 0.05 rem (0.5 mSv) to the embryo/fetus once the pregnancy is known (Ref. 2). In view of the NCRP recommendation, any monthly dose of less than 0.1 rem (1 mSv) may be considered as not a substantial variation above a uniform monthly dose rate and as such will not require licensee justification. However, a monthly dose greater than 0.1 rem (1 mSv) should be justified by the licensee.

## **D. IMPLEMENTATION**

The purpose of this section is to provide information to licensees and applicants regarding the NRC staff's plans for using this regulatory guide.

Unless a licensee or an applicant proposes an acceptable alternative method for complying with the specified portions of the NRC's regulations, the methods described in this guide will be used by the NRC staff in the evaluation of instructions to workers on the radiation exposure of pregnant women.

### REFERENCES

1. USNRC, "Instruction Concerning Risks from Occupational Radiation Exposure," Regulatory Guide 8.29, Revision 1, February 1996.

2. National Council on Radiation Protection and Measurements, Limitation of Exposure to Ionizing Radiation, NCRP Report No. 116, Bethesda, MD, 1993.

## **APPENDIX: QUESTIONS AND ANSWERS CONCERNING PRENATAL RADIATION EXPOSURE**

1. Why am I receiving this information?

The NRC's regulations (in 10 CFR 19.12, "Instructions to Workers") require that licensees instruct individuals working with licensed radioactive materials in radiation protection as appropriate for the situation. The instruction below describes information that occupational workers and their supervisors should know about the radiation exposure of the embryo/fetus of pregnant women.

The regulations allow a pregnant woman to decide whether she wants to formally declare her pregnancy to take advantage of lower dose limits for the embryo/fetus. This instruction provides information to help women make an informed decision whether to declare a pregnancy.

2. If I become pregnant, am I required to declare my pregnancy?

No. The choice whether to declare your pregnancy is completely voluntary. If you choose to declare your pregnancy, you must do so in writing and a lower radiation dose limit will apply to your embryo/fetus. If you choose not to declare your pregnancy, you and your embryo/fetus will continue to be subject to the same radiation dose limits that apply to other occupational workers.

3. If I declare my pregnancy in writing, what happens?

If you choose to declare your pregnancy in writing, the licensee must take measures to limit the dose to your embryo/fetus to 0.5 rem (5 millisievert) during the entire pregnancy. This is one-tenth of the dose that an occupational worker may receive in a year. If you have already received a dose exceeding 0.5 rem (5 mSv) in the period between conception and the declaration of your pregnancy, an additional dose of 0.05 rem (0.5 mSv) is allowed during the remainder of the pregnancy. In addition, 10 CFR 20.1208, "Dose to an Embryo/Fetus," requires licensees to make efforts to avoid substantial variation above a uniform monthly dose rate so that all the 0.5 rem (5 mSv) allowed dose does not occur in a short period during the pregnancy.

This may mean that, if you declare your pregnancy, the licensee may not permit you to do some of your normal job functions if those functions would have allowed you to receive more than 0.5 rem, and you may not be able to have some emergency response responsibilities.

4. Why do the regulations have a lower dose limit for the embryo/fetus of a declared pregnant woman than for a pregnant worker who has not declared?

A lower dose limit for the embryo/fetus of a declared pregnant woman is based on a consideration of greater sensitivity to radiation of the embryo/fetus and the involuntary nature of the exposure. Several scientific advisory groups have recommended (References 1 and 2) that the dose to the embryo/fetus be limited to a fraction of the occupational dose limit.

5. What are the potentially harmful effects of radiation exposure to my embryo/fetus?

The occurrence and severity of health effects caused by ionizing radiation are dependent upon the type and total dose of radiation received, as well as the time period over which the exposure was received. See Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Exposure" (Ref. 3), for more information. The main concern is embryo/fetal susceptibility to the harmful effects of radiation such as cancer.

6. Are there any risks of genetic defects?

Although radiation injury has been induced experimentally in rodents and insects, and in the experiments was transmitted and became manifest as hereditary disorders in their offspring, radiation has not been identified as a cause of such effect in humans. Therefore, the risk of genetic effects attributable to radiation exposure is speculative. For example, no genetic effects have been documented in any of the Japanese atomic bomb survivors, their children, or their grandchildren.

7. What if I decide that I do not want any radiation exposure at all during my pregnancy?

You may ask your employer for a job that does not involve any exposure at all to occupational radiation dose, but your employer is not obligated to provide you with a job involving no radiation exposure. Even if you receive no occupational exposure at all, your embryo/fetus will receive some radiation dose (on average 75 mrem (0.75 mSv)) during your pregnancy from natural background radiation.

The NRC has reviewed the available scientific literature and concluded that the 0.5 rem (5 mSv) limit provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers. If this dose limit is exceeded, the total lifetime risk of cancer to the embryo/fetus may increase incrementally. However, the decision on what level of risk to accept is yours. More detailed information on potential risk to the embryo/fetus from radiation exposure can be found in References 2-10.

8. What effect will formally declaring my pregnancy have on my job status?

Only the licensee can tell you what effect a written declaration of pregnancy will have on your job status. As part of your radiation safety training, the licensee should tell you the company's policies with respect to the job status of declared pregnant women. In addition, before you declare your pregnancy, you may want to talk to your supervisor or your radiation safety officer and ask what a declaration of pregnancy would mean specifically for you and your job status.

In many cases you can continue in your present job with no change and still meet the dose limit for the embryo/fetus. For example, most commercial power reactor workers (approximately 93%) receive, in 12 months, occupational radiation doses that are less than 0.5 rem (5 mSv) (Ref. 11). The licensee may also consider the likelihood of increased radiation exposures from accidents and abnormal events before making a decision to allow you to continue in your present job.

If your current work might cause the dose to your embryo/fetus to exceed 0.5 rem (5 mSv), the licensee has various options. It is possible that the licensee can and will make a reasonable accommodation that will allow you to continue performing your current job, for example, by having another qualified employee do a small part of the job that accounts for some of your radiation exposure.

9. What information must I provide in my written declaration of pregnancy?

You should provide, in writing, your name, a declaration that you are pregnant, the estimated date of conception (only the month and year need be given), and the date that you give the letter to the licensee. A form letter that you can use is included at the end of these questions and answers. You may use that letter, use a form letter the licensee has provided to you, or write your own letter.

10. To declare my pregnancy, do I have to have documented medical proof that I am pregnant?

NRC regulations do not require that you provide medical proof of your pregnancy. However, NRC regulations do not preclude the licensee from requesting medical documentation of your pregnancy, especially if a change in your duties is necessary in order to comply with the 0.5 rem (5 mSv) dose limit.

11. Can I tell the licensee orally rather than in writing that I am pregnant?

No. The regulations require that the declaration must be in writing.

12. If I have not declared my pregnancy in writing, but the licensee suspects that I am pregnant, do the lower dose limits apply?

No. The lower dose limits for pregnant women apply only if you have declared your pregnancy in writing. The United States Supreme Court has ruled (in *United Automobile Workers International Union v. Johnson Controls, Inc.*, 1991) that "Decisions about the welfare of future children must be left to the parents who conceive, bear, support, and raise them rather than to the employers who hire those parents" (Reference 7). The Supreme Court also ruled that your employer may not restrict you from a specific job "because of concerns about the next generation." Thus, the lower limits apply only if you choose to declare your pregnancy in writing.

13. If I am planning to become pregnant but am not yet pregnant and I inform the licensee of that in writing, do the lower dose limits apply?

No. The requirement for lower limits applies only if you declare in writing that you are already pregnant.

14. What if I have a miscarriage or find out that I am not pregnant?

If you have declared your pregnancy in writing, you should promptly inform the licensee in writing that you are no longer pregnant. However, if you have not formally declared your pregnancy in writing, you need not inform the licensee of your non-pregnant status.

15. How long is the lower dose limit in effect?

The dose to the embryo/fetus must be limited until you withdraw your declaration in writing or you inform the licensee in writing that you are no longer pregnant. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

16. If I have declared my pregnancy in writing, can I revoke my declaration of pregnancy even if I am still pregnant?

Yes, you may. The choice is entirely yours. If you revoke your declaration of pregnancy, the lower dose limit for the embryo/fetus no longer applies.

17. What if I work under contract at a licensed facility?

The regulations state that you should formally declare your pregnancy to the licensee in writing. The licensee has the responsibility to limit the dose to the embryo/fetus.

18. Where can I get additional information?

The references to this Appendix contain helpful information, especially Reference 3, NRC's Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," for general information on radiation risks. The licensee should be able to give this document to you.

For information on legal aspects, see Reference 7, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children--What Can the Employer Do?" which is an article in the journal Radiation Protection Management.

You may telephone the NRC Headquarters at (301) 415-7000. Legal questions should be directed to the Office of the General Counsel, and technical questions should be directed to the Division of Industrial and Medical Nuclear Safety.

You may also telephone the NRC Regional Offices at the following numbers: Region I, (610) 337-5000; Region II, (404) 562-4400; Region III, (630) 829-9500; and Region IV, (817) 860-8100. Legal questions should be directed to the Regional Counsel, and technical questions should be directed to the Division of Nuclear Materials Safety.

## REFERENCES FOR APPENDIX

1. National Council on Radiation Protection and Measurements, Limitation of Exposure to Ionizing Radiation, NCRP Report No. 116, Bethesda, MD, 1993.
2. International Commission on Radiological Protection, 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, Ann. ICRP 21: No. 1-3, Pergamon Press, Oxford, UK, 1991.
3. USNRC, "Instruction Concerning Risks from Occupational Radiation Exposure," Regulatory Guide 8.29, Revision 1, February 1996.1(1) (Electronically available at [www.nrc.gov/NRC/RG/index.html](http://www.nrc.gov/NRC/RG/index.html))
4. Committee on the Biological Effects of Ionizing Radiations, National Research Council, Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V), National Academy Press, Washington, DC, 1990.
5. United Nations Scientific Committee on the Effects of Atomic Radiation, Sources and Effects of Ionizing Radiation, United Nations, New York, 1993.
6. R. Doll and R. Wakeford, "Risk of Childhood Cancer from Fetal Irradiation," The British Journal of Radiology, 70, 130-139, 1997.
7. David Wiedis, Donald E. Jose, and Timm O. Phoebe, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children--What Can the Employer Do?" Radiation Protection Management, 11, 41-49, January/February 1994.
8. National Council on Radiation Protection and Measurements, Considerations Regarding the Unintended Radiation Exposure of the Embryo, Fetus, or Nursing Child, NCRP Commentary No. 9, Bethesda, MD, 1994.

9. National Council on Radiation Protection and Measurements, Risk Estimates for Radiation Protection, NCRP Report No. 115, Bethesda, MD, 1993.
10. National Radiological Protection Board, Advice on Exposure to Ionising Radiation During Pregnancy, National Radiological Protection Board, Chilton, Didcot, UK, 1998.
11. M.L. Thomas and D. Hagemeyer, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, 1996," Twenty-Ninth Annual Report, NUREG-0713, Vol. 18, USNRC, 1998.(2)

## **REGULATORY ANALYSIS**

A separate regulatory analysis was not prepared for this regulatory guide. A regulatory analysis prepared for 10 CFR Part 20, "Standards for Protection Against Radiation" (56 FR 23360), provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the "Regulatory Analysis for the Revision of 10 CFR Part 20" (PNL-6712, November 1988) is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW, Washington, DC, as an enclosure to Part 20 (56 FR 23360).

1. Single copies of regulatory guides, both active and draft, and draft NUREG documents may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161. Copies of active and draft guides are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; telephone (202)634-3273; fax (202)634-3343.
2. Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; telephone (202)634-3273; fax (202)634-3343

## WKU FORM LETTER FOR DECLARING PREGNANCY

This form letter is provided for your convenience. To make your written declaration of pregnancy, you may fill in the blanks in this form letter or you may write your own letter.

### DECLARATION OF PREGNANCY

To: \_\_\_\_\_, Radiation Safety Officer

In accordance with Kentucky's regulations at

**902 KAR 100:019, Section 9, Dose to an Embryo or Fetus,**

I am declaring that I am pregnant. I believe I became pregnant in \_\_\_\_\_ (only the month and year need be provided).

I understand the radiation dose to my embryo/fetus during my entire pregnancy will not be allowed to exceed 500 millirem (5 millisievert), unless that dose has already been exceeded between the time of conception and submitting this letter. I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

\_\_\_\_\_ (Signature)

\_\_\_\_\_ (Printed Name)

\_\_\_\_\_ (Date)

#### RSO USE ONLY

Date Declaration Received: \_\_\_\_\_

Date Fetal Dosimeter Ordered: \_\_\_\_\_

Date Fetal Dosimeter Delivered: \_\_\_\_\_

## APPENDIX O – RECORDS REQUIRED

Radioactive material licensees are required to maintain a number of records. This form summarizes the records that are required to be kept in conjunction with licensed radioactive material operations at WKU. Some records may not be applicable for certain uses.

REGULATION	TYPE OF RECORD
902 KAR 100:019	Records of employee’s prior exposure history (NRC Form 4)
902 KAR 100:019	A written evaluation of expected exposure in excess of that permitted under 902 KAR 100:019
902 KAR 100:019	Records of surveys preserved as specified in 902 KAR 100:019 (this includes receipt surveys, contamination surveys, etc.)
902 KAR 100:019	Records of radiation exposure on NRC Form 5 or all other forms containing all the information required by NRC Form 5. (This information is usually contained in vendor’s film badge exposure reports)
902 KAR 100:019	Records of radiation exposure to individual members of the public
902 KAR 100:019	Records of the provisions of the radiation safety program, audits and other reviews of program content and implementation.
902 KAR 100:021	Waste shipment certification to accompany each shipment of radioactive waste to the low-level radioactive waste burial site
902 KAR 100:021	Records of disposal by release into sanitary sewerage systems proving compliance with limits in 902 KAR 100:021
902 KAR 100:040	General provisions require records of receipt use, storage, transfer and/or disposal of radiation sources
902 KAR 100:060	Records of leak tests
902 KAR 100:165	Records of instructions to workers

NOTE: Where records of surveys and monitoring are required, the records must show the units in this part, i.e., millirem per hour for external radiation, microcuries for removable contamination, etc. It is not sufficient to just indicate that a survey was performed. The actual reading has to be recorded with location of the reading. The survey report should also give a numerical interpretation of background, and not state merely that the reading was less than background.

## APPENDIX P – SEALED SOURCE RADIATION EMERGENCY PROCEDURES

### PERSONNEL INJURY

WITH SIGNIFICANT OR LIFE-THREATENING INJURIES, MEDICAL ATTENTION IS THE FIRST PRIORITY

Call 911. If necessary, report a potentially contaminated injury. Describe the extent of injuries and the radioactive material(s) involved. If the injury is minor, remove contaminated clothing and wash potentially contaminated areas with running water. Contact the RSO.

### RUPTURED OR LEAKING SEALED SOURCE

- Do not move or remove the source or device containing the source.
- Evacuate personnel from the area in which the source or device is located and restrict further movement of potentially contaminated personnel beyond a safe area to limit spread of contamination (the RSO will survey these individuals before release).
- Restrict access to area in which leaking source is located.
- Do not allow potentially contaminated materials to be removed from the laboratory or work area until authorized by the RSO.
- Notify the RSO

### MINOR FIRES

- Immediately attempt to put out the fire by approved methods (i.e., fire extinguisher) if there is NO immediate danger from either the fire or radiation and if you have been properly trained in the use of a fire extinguisher.
- Notify all persons to vacate the area and have one individual immediately set off the fire alarm at the nearest pull station, call 911 and the RSO.
- Once the fire is out, isolate the area to prevent the spread of possible contamination.
- Survey all persons involved in combating the fire for possible contamination.
- Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water, then washing with a mild soap.
- Consult with the RSO to determine a decontamination plan.
- Allow no one to return to work in the area unless approved by the RSO.

### MAJOR FIRES, EXPLOSIONS, OR MAJOR EMERGENCIES

- Notify all persons in the area to leave immediately.
- Set off fire alarm at the nearest pull station
- Call 911 and notify them there is a potential radiation hazard in addition to the emergency.
- Immediately notify the RSO.
- Upon arrival of firefighters, inform them where radioactive materials are stored or where radioisotopes were being used; inform them of the present location of the licensed material and the best possible entrance route to the radiation area, as well as any precautions to avoid exposure.
- Allow no one to return to work in the area unless approved by the RSO.

### LOSS OR THEFT

Report the LOSS or THEFT of radioactive material immediately to the Authorized User and the Radiation Safety Officer.  
If there is no answer, call the WKU Police

Radiation Safety Officer, Sarah Grant, 270-745-3597 (O), 270-535-4822 (C) WKU Police: 270-745-2548

Authorized User \_\_\_\_\_ Phone \_\_\_\_\_

## APPENDIX Q – UNSEALED SOURCE RADIATION EMERGENCY PROCEDURES

### PERSONNEL INJURY

#### WITH SIGNIFICANT OR LIFE-THREATENING INJURIES, MEDICAL ATTENTION IS THE FIRST PRIORITY

Call 911. If necessary, report a potentially contaminated injury. Describe the extent of injuries and the radioactive material(s) involved. If the injury is minor, remove contaminated clothing and wash potentially contaminated areas with running water. Contact the RSO.

### MINOR SPILLS: USUALLY LIQUID OR SOLIDS SPILLS CONFINED TO SMALL, LOW-TRAFFIC AREAS

- Notify persons in the area that a spill has occurred.
- Open the spill kit and remove the needed supplies and personal protective equipment.
- Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened if solids are spilled).
- Clean up the spill, wearing disposable gloves and using absorbent paper.
- Carefully fold the absorbent paper with the clean side out and place in a bag for transfer to a radioactive waste container. Put contaminated gloves and any other contaminated disposable material in the bag.
- Survey the area with an appropriate low-range radiation detector survey meter or other appropriate technique (such as a wipe test analyzed on a liquid scintillation analyzer). Check the area around the spill for contamination. Also check hands, clothing, and shoes for contamination.
- Promptly report the incident to the RSO and let him/her know if you need assistance.
- Allow no one to return to work in the area unless approved by the RSO.

### MAJOR SPILLS: USUALLY LIQUID OR SOLIDS SPILLS OVER LARGE OR HIGH-TRAFFIC AREAS

- Clear the area. Notify all persons not involved in the spill to vacate the room.
- Open the spill kit and remove the needed supplies and personal protective equipment.
- Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened if solids are spilled), but DO NOT attempt to clean it up. Confine the movement of all potentially contaminated personnel to prevent the spread.
- Shield the source only if it can be done without further contamination or significant increase in radiation exposure.
- Close the room and lock or otherwise secure the area to prevent entry. Post the room with a sign to warn anyone trying to enter that a spill of radioactive material has occurred.
- Notify the RSO immediately.
- Survey all personnel who could possibly have been contaminated. Decontaminate personnel by removing contaminated clothing and flushing the contaminated skin with lukewarm water and then washing with a mild soap. The spill kit also has Radcon hand cleaner or similar.
- Allow no one to return to work in the area unless approved by the RSO.

### MINOR FIRES

- Immediately attempt to put out the fire by approved methods (i.e., fire extinguisher) if there is NO immediate danger from either the fire or radiation and if you have been properly trained in the use of a fire extinguisher.
- Notify all persons to vacate the area and have one individual immediately set off the fire alarm at the nearest pull station, call 911 and the RSO.
- Once the fire is out, isolate the area to prevent the spread of possible contamination.
- Survey all persons involved in combating the fire for possible contamination.
- Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water, then washing with a mild soap.
- Consult with the RSO to determine a decontamination plan.
- Allow no one to return to work in the area unless approved by the RSO.

### MAJOR FIRES, EXPLOSIONS, OR MAJOR EMERGENCIES

- Notify all persons in the area to leave immediately.
- Set off fire alarm at the nearest pull station
- Call 911 and notify them there is a potential radiation hazard in addition to the emergency.
- Immediately notify the RSO.
- Upon arrival of firefighters, inform them where radioactive materials are stored or where radioisotopes were being used; inform them of the present location of the licensed material and the best possible entrance route to the radiation area, as well as any precautions to avoid exposure.
- Allow no one to return to work in the area unless approved by the RSO.

### LOSS OR THEFT

Report the LOSS or THEFT of radioactive material immediately to the Authorized User and the Radiation Safety Officer.  
If there is no answer, call the WKU Police

Authorized User \_\_\_\_\_ Phone \_\_\_\_\_  
Radiation Safety Officer, Sarah Grant, 270-745-3597 (O), 270-535-4822 (C)

WKU Police: 270-745-2548



5	Decontaminate all wastes (by autoclaving, or chemically as appropriate) and dispose of per University regulations.	<input type="checkbox"/>
6	Decontaminate all work surfaces and storage areas.  Indicate disinfectant used: 10% bleach with 30 min soaking 70% ethanol with 30 min soaking Other – specify type and concentration:	<input type="checkbox"/>
7	Biohazard labels removed after decontamination.	<input type="checkbox"/>
<b>Radiation</b>	<b>Radioactivity</b> - Are/Were sources of radioisotopes utilized or radiation-producing machines present? If <b>No</b> , go to X-ray Equipment.	
8	If YES, relocate any radioactive materials to another permitted location and update inventory as appropriate OR arrange to transfer unwanted stock vials and sources with EHS.  Properly dispose of waste and confirm leak/contamination testing  <b>Door signs and Radioisotope Permits may only be removed by Radiation Safety Officer.</b>	<input type="checkbox"/> <input type="checkbox"/>
9	<b>X-ray Equipment</b> - Is there X-ray Equipment in this room? If <b>No</b> , go to Laser – Open Beam.	
10	If YES, relocate X-ray Equipment to another room.  Before X-ray Equipment may be used in a new location, Radiation Safety Officer must be informed to determine if leakage tests, permit amendments and/or notification of the province is required.  <b>Door signs and X-ray Permits may only be removed by Radiation Safety Officer.</b>	<input type="checkbox"/> <input type="checkbox"/>
11	<b>Laser – Open Beam</b> - Is this room signed "Danger Laser? If <b>No</b> , go to Supplies and Lab Equipment.	
12	If YES, relocate laser(s) to another room  Inform Laser Safety Officer of the change of status related to the lasers.	<input type="checkbox"/> <input type="checkbox"/>
<b>Supplies and Lab Equipment</b>		
13	Remove all lab supplies and equipment for room including items in drawers and cabinets and on shelves.  Be sure to update capital assets as appropriate.	<input type="checkbox"/> <input type="checkbox"/>
14	Inspect all areas for needles, razor blades, scalpel blades and broken glass.  Dispose of sharps in a puncture proof container.  Dispose of unwanted glassware and brittle plastic in plastic bag lined cardboard boxes or commercial 'Broken Glass' boxes.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<b>Cleaning</b>		
15	Remove all visible residues, standing liquids, loose particulate material from bench tops, shelves, cabinets, inside drawers and floors.  Wipe all accessible surfaces with mild detergent such as soap and water.	<input type="checkbox"/> <input type="checkbox"/>
16	Clean out fume hood.  <input type="checkbox"/> check if there is/are no fume hood(s) in the room	<input type="checkbox"/>
17	Place all general garbage in garbage or recycling cans, as appropriate.	<input type="checkbox"/>

18	<p>Is it possible hazardous products (radiological, biological or chemical materials) may be present in the building systems?</p> <p style="text-align: right;"> <input type="checkbox"/> Not applicable                <input type="checkbox"/> fume hood ducts                <input type="checkbox"/> drains/traps                <input type="checkbox"/> other – specify:           </p>
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<b>Signature confirms information supplied in form is accurate:</b>		
<b>DECLARATION OF COMPLIANCE:</b>		
_____		_____
<b>Signature</b>		<b>Date</b>
<b>Reviewed by EHS</b>	<b>Hazard Decommissioning</b>	<b>Records</b>
Name Signature Date	Chemicals Biologicals Radiation	Registered equipment updated? List Permit(s) to be updated: Academic Department Compliance:

## APPENDIX S – RADIATION SAFETY TRAINING AND DOSIMETRY REQUEST FORM

RADIATION WORKER INFORMATION	
Full Name: _____	Today's Date: _____
WKU ID#: _____	Date of Birth: _____ Sex: <input type="checkbox"/> M <input type="checkbox"/> F
Department: _____	
Position Title: _____	WKU Employment Status:
Telephone: _____	<input type="checkbox"/> Faculty <input type="checkbox"/> Staff <input type="checkbox"/> Student
E-mail: _____	<input type="checkbox"/> Adjunct Faculty <input type="checkbox"/> Adjunct Staff
Supervisor Name: _____	<input type="checkbox"/> Non-WKU, Employer Name: _____

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**RADIATION SAFETY TRAINING REQUEST**

Type of Radiologicals to be Used (Select all that apply):

XRF XRD Van de Graaff Accelerator D-D Neutron Generator  
Other (specify), \_\_\_\_\_ Open Source Sealed Sources

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**DOSIMETRY REQUEST AND PRIOR DOSE HISTORY**

Type of Dosimeter Requested (Select all that apply):

Whole Body  
Radiation Type(s) Beta Gamma X-ray Neutron

Ring  
Right Finger Left Finger, Small Medium Large  
Radiation Type(s) Beta Gamma X-ray

Have you ever worn a radiation dosimeter other than at WKU? Yes No  
If yes, provide the complete name and address of the employer and the time period employed.

Previous Employer Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Address 2: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_  
Country: \_\_\_\_\_

Employment Dates From \_\_\_\_\_ to \_\_\_\_\_

I hereby authorize my previous employer to release my prior radiation exposure history to Western Kentucky University Department of Environment, Health & Safety.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_