

# RADIATION SAFETY MANUAL

FOR USE AT

# KANSAS STATE UNIVERSITY

Prepared by the

Department of Environmental Health and Safety

Kansas State University

June 2023



# EMERGENCY INFORMATION

In the event of an accident involving radioactive material or a radiation producing device, contact:

During regular hours,

**DEPARTMENT OF ENVIRONMENTAL HEALTH & SAFETY** . . . . . (785) 532-5856

After hours,

**UNIVERSITY POLICE** . . . . . (785) 532-6412  
and request the Radiation Safety Officer be contacted

Also see Accident Procedures, Section 4.12, page 14.

If the accident involves personal injury or fire,  
also immediately call:

**911**

# PREFACE

This manual is a guide toward achieving safety in the use of radiation. These recommendations and requirements should be supplemented with good judgment and an understanding of the radiation safety program objectives. The objectives are to permit full utilization of radiation in a manner that will ensure the safety of all persons and to minimize equipment or time losses resulting from radioactive contamination.

To establish operating practices that will minimize hazard in the use of radiation and/or radioactive materials at Kansas State University, a Radiation Safety Committee has been appointed by the President of the University. This manual, prepared by the Committee, describes general procedures that apply specifically to Kansas State University and is to be used in conjunction with the State of Kansas Radiation Protection Regulations. The requirements set forth in this manual are minimal precautions. Additional precautions formulated by the user and/or the Committee may be necessary. The precautions are, in some cases, binding upon the University by law or contractual agreement.

The extent to which radiation safety is practiced in the laboratory depends not only on the quality of the safety-related information provided, but also on the willingness of the individual researcher to put this information into practice. This manual is intended to provide sufficient information to enable radiation safety practices at Kansas State University to be of the highest quality. It is, however, the responsibility of each researcher, student, staff, or faculty who works with radioactive materials or a radiation-producing device to become familiar with the contents of this manual and to observe the procedures and requirements that are applicable to their particular work.

These regulations supersede previous regulatory information and may be supplemented in the future. This manual should be retained in such form that supplementary material can be added and reviewed periodically.

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# 1.0 INTRODUCTION

The use of radioactive materials and radiation producing devices in our society has expanded continuously since the discoveries of radioactivity and x-rays in the late 19th century, and has become important as a tool in research and teaching at the University.

As the use of materials and devices that emit ionizing radiation grew, so did our understanding of the potential hazards associated with their use. These hazards began to be appreciated in the early half of the 20th century when adverse health effects were first observed in individuals who had been exposed to ionizing radiation. Concern over health risks associated with radiation exposure led very early to recommended exposure limits and, ultimately, to mandatory limits and strict regulatory controls governing the possession and use of all sources of ionizing radiation.

Current limits for radiation exposure are based on the conservative assumption that there is no completely safe level of exposure. In other words, even the smallest exposure has some probability of causing a late effect such as cancer or genetic damage. This assumption has led to the general philosophy of not only keeping exposures below recommended levels or regulatory limits, but of also maintaining all exposures "**As Low As Reasonably Achievable**" (**ALARA**). ALARA is a fundamental tenet of current radiation safety practice.

This manual presents the information and procedures which must be understood and practiced in order to ensure that all users of ionizing radiation at Kansas State University are in compliance with existing regulatory requirements and that any resultant radiation exposures are consistent with the ALARA principle.

## 2.0 DEFINITIONS

The following definitions are used in this manual. For definitions of other terms see the State of Kansas Radiation Protection Regulations.

**API** - Authorized Principal Investigator; the individual who holds a radioactive materials use permit.

**Committee** - the Radiation Safety Committee of Kansas State University (RSC).

**Radiation** - gamma rays and X-rays, alpha and beta particles, high speed electrons, neutrons and other nuclear particles; does not include sound or radio waves, or visible, infrared, or ultraviolet light.

**Radiation Worker** - any person who works with radiation. The Authorized Principal Investigator and the Radiation Safety Officer will decide if an individual is a radiation worker.

**Radioisotope** - for the purpose of this manual, any material, solid, liquid, or gas which emits radiation spontaneously, unless otherwise specified by the University Radiation Safety Officer.

**Radioisotope Laboratory** - any room which contains radioisotopes in amounts in excess of 5 millicuries of natural uranium or thorium, or more than a generally licensed quantity of any other radioactive material. Rooms containing only sealed sources or used exclusively for storage may be excepted on approval from the University Radiation Safety Officer.

**RSO** - University Radiation Safety Officer or his/her designee.

**State** - the State of Kansas acting through the Kansas Department of Health and Environment (KDHE), Bureau of Community Health Systems, Radiation Control Program.

**University** - Kansas State University.



## **3.0 GENERAL POLICIES**

### **3.1 SCOPE OF THE MANUAL.**

This manual sets forth the procedures approved by the Kansas State University Radiation Safety Committee for those individuals who use radiation sources. All individuals working with radiation are required to familiarize themselves with this manual. National Institute of Standards and Technology Handbooks and Nuclear Regulatory Commission Regulatory Guides are recommended as sources of additional information. For additional material, contact the Department of Environmental Health and Safety.

### **3.2 POLICY OF THE RADIATION SAFETY COMMITTEE.**

It is the policy of the Radiation Safety Committee that all exposures to radiation shall be as low as reasonably achievable (ALARA) and consistent with that required to perform the work. In no case shall the exposure exceed the permissible levels established by the U.S. Nuclear Regulatory Commission, or the State of Kansas.

### **3.3 RESPONSIBILITIES OF THE RADIATION SAFETY COMMITTEE.**

- a. To formulate and promulgate University policies concerning the acquisition, use, and disposal of radioactive material and radiation producing machines.
- b. To establish administrative controls to ensure compliance by individual users with University, State, and Federal regulations.
- c. To critically review, in advance for each API, each separate use or category of use of radioactive material, and approve or disapprove the proposed project.
- d. To establish possession limits and restrictions of use for each API.
- e. To investigate incidents involving sources of radiation for the purpose of determining causes and means for preventing their recurrence.
- f. To meet not less than four (4) times each year.

### **3.4 RESPONSIBILITIES OF THE RADIATION SAFETY OFFICER.**

- a. To advise and assist new APIs with regard to radiation use and radiation safety and assist them in preparing applications for Committee consideration.
- b. To investigate each proposed new use of radioactive materials and make recommendations thereon to the Committee.
- c. To establish emergency procedures and supervise the handling of incidents involving radioactive materials.

- d. To perform periodic surveys and continuing surveillance over all radioactive material users to ensure compliance with good radiological health practices and with regulations as prescribed by the Kansas Department of Health and Environment (KDHE), Federal Agencies, and the University.
- e. To provide dosimetry services and to maintain personnel exposure records.
- f. To maintain central records required by the Kansas Radiation Protection Regulations and by the University.
- g. To provide waste disposal consultation for radioactive wastes. The disposal of such wastes shall be approved by the RSO or his/her designee. (See Disposal of Radioactive Waste, Section 4.15)
- h. To prepare applications for amendments to the University's State of Kansas Radioactive Materials License and to carry out related correspondence.
- i. To disseminate information to APIs on new developments in the University's license and policies, the KDHE's Regulations and/or, the Nuclear Regulatory Commission's Rules and Regulations.
- j. To ensure that day to day operations involving radioactive materials are conducted according to the policies and procedures designed to maintain personnel and public exposures ALARA.
- k. To be knowledgeable about the details of the license program and applicable regulatory requirements.
- l. To provide safety training for all radiation users.
- m. To maintain security of licensed material.

### **3.5 RESPONSIBILITIES OF THE ASSISTANT RADIATION SAFETY OFFICER.**

The Assistant Radiation Safety Officer shall carry out those duties and obligations assigned to him/her by the Radiation Safety Officer. In addition, he/she shall serve as the RSO in the absence of the RSO.

### **3.6 DUTIES AND RESPONSIBILITIES OF THE AUTHORIZED PRINCIPAL INVESTIGATOR.**

Primary responsibility for radiation safety is vested in the person who is directing the project utilizing radiation. Specific duties and responsibilities are:

- a. To obtain prior approval from the Committee before possessing or using any radioactive substance or source of high energy radiations or particles.
- b. To have sufficient knowledge of the properties of the radioactive material or radiation he/she proposes to use and to be able to evaluate the possible hazards associated with the type and amount of material or radiation involved.
- c. To know what protective measures are necessary and to ensure that such protective measures will be taken.
- d. To maintain records of receipt, use, decay, and disposal of radioactive material.

- e. To follow procurement and disposal procedures as described in Sections 4.5 and 4.15 respectively.
- f. To report immediately to the RSO any accident involving radioactive substances or radiation producing machines.
- g. To report to the RSO any major changes in the research procedures, and changes in personnel directly concerned with the project.
- h. To report to the RSO, prior to any extended absence of the API, the name of the person who will assume responsibility for the project in his/her absence.
- i. To ensure that the provisions of the individual laboratory radiation safety plan are commensurate with the potential for radiation exposures to individual workers and to members of the public and are in keeping with the ALARA concept as required in the Code of Federal Regulations, Title 10, Part 20. The Radiation Safety Committee will make the final determinations for the depth of each ALARA program.
- j. To ensure that personnel radiation monitors (badges, rings) used by individuals under his/her jurisdiction are returned to the Department of Environmental Health and Safety prior to the time the individual wearer leaves the University.

### **3.7 ENFORCEMENT.**

The requesting and receiving of permission to use radioactive materials at Kansas State University carry with them the assumption of responsibility by each user to promote radiation safety and to adhere to the safety standards described in this manual. It is the responsibility of each user to eliminate any known unsafe practice or report same to the RSO.

The RSO is empowered to stop, in the interest of safety, any experiment involving radiation. This authority may be delegated if such specific delegation is approved by the Committee.

The Radiation Safety Committee is empowered to deny an individual access to radioactive materials or radiation producing devices at any time in the interest of safety. An individual so penalized has the right to appeal to the President of the University.

### **3.8 COMPLIANCE.**

The University must meet the requirements of its State of Kansas License for the possession and use of radioactive materials and be in compliance with State Regulations and University Policies. As stated in the Radiation Safety Plan, this enforcement is the duty of the RSO. A system of notification and a regular schedule of compliance serve as guidelines for the RSO and advanced notice to the API. Failure to respond within the time frame triggers a second notice to the API and copies will be sent to the API supervisor (department head or other appropriate person) and the chair of the RSC. The intent of the second notice is not only a reminder from their supervisor, but in the event the API is unavailable, the supervisor can inform the RSO of the status of the laboratory. If no response to the second notice is received within the same time frame, a third notice will be sent to the API with copies to the supervisor, dean of the college, chair of the RSC, and chair of the college safety committee. Failure to respond to the third notice within the same time frame will result in suspension of the API use permit, removal of

all isotopes from the laboratory by the RSO, and review of the situation by the RSC to consider further action.

The following table shows some compliance issues and the time frame for response.

Type of Notice	Response Time Frame
Inspection Violation Letter	30 days
Quarterly Inventory Report Form	14 days
Other Issues (including training notices)	As stated on notice

**Radiation Safety Training.** As part of the compliance policy, the RSO will send a notice to all APIs regarding initial or updated training required by laboratory personnel. The response time frame above will apply with follow-up notices. Additionally, the API will be denied delivery of new radioisotope until training is completed.

**Laboratory Inspections.** As in the table above, the API has 30 days to correct a violation and respond to the violation letter. A repeat violation triggers a follow-up inspection in 30 days. If the violation is not corrected at that time, the laboratory permit will be suspended. Review by the RSC will decide what further action is necessary. Additionally, the RSO will keep track of violations. APIs with frequent occurrences will be discussed at a subsequent RSC meeting with consideration for sanctions such as increased limits on authorization or possible non-renewal.

**Flagrant Violation.** These violations of Kansas State University Policies or State Regulations present an immediate threat to the health and safety of laboratory personnel and/or the environmental conditions of the University. Such violations will result in the immediate suspension of the laboratory permit. Review by the RSC will be necessary for reinstatement. The following are examples of flagrant violations.

- Receipt of radioisotopes without authorization or initial inspection (and inventory logging) of the package by the RSO.
- Use of radioisotopes with disregard for personal safety or the safety of other personnel in the laboratory.
- Use of radioisotopes by a laboratory member who has not been issued personal radiation dosimetry when required by the approved isotope procedure in the laboratory. This violation shall also apply to persons who have been issued dosimetry but repeatedly (more than once) fail to use it.
- Use of radioisotopes by a laboratory member who has not completed the initial Radiation Safety Training as evidenced by a certificate bearing the personal identification number of the recipient.
- Failure to report or clean up a radioisotope spill.

### **3.9 MEDICAL EXAMINATIONS.**

The need for a medical examination will be determined by the Chief of Staff of Lafene Health Center and the Radiation Safety Officer. Past radiation exposures, a study of health records, and the proposed use of radiation will help to determine if a medical examination is required.

## **4.0 RADIOACTIVE MATERIALS**

### **4.1 AUTHORIZATION TO USE RADIOACTIVE MATERIALS.**

Procedure for obtaining authorization to use radioisotopes, whether the radioisotope is to be obtained from a commercial firm, a non-commercial source, or is to be produced by irradiation of materials in a reactor, accelerator, or other device, is as follows:

- a. The applicant shall fill out three copies of the form RSC-1, "Application for Authorization to Use Radioactive Materials at Kansas State University" (See Appendix 9.1). Two copies of this application shall be forwarded to the RSO, Department of Environmental Health & Safety.
- b. After receipt of the application, the RSO will visit the applicant to:
  - 1) Discuss the project with a view for further evaluation of the radiation hazards, and the possibility of contamination.
  - 2) Evaluate the radioisotope laboratory of the applicant (layout, floors, walls, benches, hoods, etc.).
  - 3) Determine whether dosimetry service, urinalysis, or other checks on hazards are required.
  - 4) Explain to the applicant the nature and extent of documentation required for compliance with the regulations of the State of Kansas.
  - 5) Evaluate the laboratory radiation safety plan.
  - 6) Discuss good radiation safety practices.
- c. Depending upon the proposed project and the amount of radioactive material requested on the Authorization request, the application may be tentatively approved by the RSO. Full approval will be considered at the next RSC meeting. If the proposal appears to be especially hazardous, a large amount of material is requested, or a large level of activity is requested, the RSO will present the proposal to the Committee for their consideration. If approved, the RSO will send the applicant a signed copy of the Authorization for each radioisotope.

### **4.2 MODIFICATION OF AUTHORIZATION.**

Requests for modifications or amendments may be submitted by the API on departmental letterhead or by form RSC-1 to the RSO. All necessary information relative to the Authorization change should be included in the request. Modifications in procedures that require the RSO to be notified are:

- a. Change in individual users.
- b. Increase in possession limits of radioisotopes.
- c. Change in procedures or purposes for which the radioisotopes are used.
- d. Change in location of laboratories for use or storage.

- e. Change of status to inactive. Inactive status is similar to termination of the Authorization, but can be reversed on short notice.

### **4.3 RENEWAL OF AUTHORIZATION.**

Authorizations expire automatically on December 15 every year. Application for renewal must be made prior to the expiration date. An application form for this purpose will be forwarded to the API by the RSO.

### **4.4 TERMINATION OF AUTHORIZATION.**

Authorization may be terminated at any time at the request of the API. If the API permanently leaves the University, authorization must be terminated. Necessary arrangements must be made before departure. The procedure to be followed is given below.

- a. All radioisotope must be transferred to another API or given to the RSO for disposal.
- b. All radioactive waste must be properly disposed (See section 4.15).
- c. Laboratory space must be clean and free of radioactive contamination (See Section 4.7).

When an API will be temporarily away from the University (leave of absence, sabbatical, extended illness, etc.), arrangements must be made for a temporary supervisor to be responsible for the duties of the API (See section 3.6). That individual must be well acquainted with procedures for use of radioactive materials at the University and have sufficient experience with radioactive materials to ensure their safe use. Another API is preferred.

### **4.5 PROCUREMENT.**

- a. With the exception of Generally Licensed Devices, no radioisotope may be obtained from any source without prior authorization by the Radiation Safety Committee. Generally Licensed Devices must be registered with the RSO so they may be properly registered with the State of Kansas. For more information, contact the RSO.
- b. When a Form RSC-1 (Application for Authorization to Use Radioactive Materials at Kansas State University) detailing the specific use of radioisotopes by a specific individual or individuals at a specific location has been approved by the Radiation Safety Committee (See Section 4.1) and is on file with the RSO, and Form RSC-2, "Radiation Source Purchase Record" (See Appendix 9.2) has been submitted to the RSO, radioactive material covered by the individual's authorization may be procured by the usual University purchasing procedures. A Form RSC-2 must be submitted for each purchase, including repeated identical uses. A new Form RSC-1 is not required for each new purchase.
- c. The Agency Payment Voucher must be submitted to the RSO for approval before being sent to the University Purchasing Office. The RSO will sign the voucher and forward it to the Purchasing Office.

## **4.6 DELIVERY.**

Radioactive material will be received at one location. The RSO or his/her designee will open all shipments to ensure that no breakage or leakage occurred during transport. Isotope will be brought to the authorized laboratory by Radiation Safety Office personnel along with a Radioisotope Usage and Disposal log sheet.

Packages are to be addressed as follows:

Radiation Safety Office  
Department of Environmental Health and Safety  
Kansas State University  
135 Dykstra Hall  
1628 Claflin Road  
Manhattan, Kansas 66506-0900

ATTN: (Authorized Principal Investigator)

## **4.7 LOCATION OF USE AND/OR STORAGE.**

All areas in which radioisotopes are used or stored must be approved by the RSO (See Section 4.1.b.2).

Before any area where radioisotopes have been used or stored is vacated, it must be cleaned by the user and then checked for contamination by the RSO. The area may be released for general use only after it is found to be free of radioactive contamination by the RSO.

## **4.8 INVENTORY.**

A quarterly inventory report form will be sent to each API at the first of each reporting month (January, April, July, and October). The inventory form is used to report amounts of radioisotopes on hand and an accounting of amounts disposed. It must be returned to the RSO prior to the fifteenth (15th) of the month. See Compliance Policy (Section 3.8) for information regarding late submission of these reports.

Radioisotope Usage and Disposal log sheets, provided by the RSO at the time of package delivery, must be maintained by the users in the laboratory. When the package of material for each log sheet is totally disposed, the log sheet must be returned to the RSO.

## **4.9 TRANSFER OF RADIOISOTOPES.**

Responsibility for radioisotopes may not be transferred from one person to another within the University unless the receiving individual, his/her location of isotope use and/or storage, and



his/her specific project have an approved Form RSC-1 authorized for the specific isotope/amount on file with the RSO prior to the transfer.

- a. Internal transfer requests shall be sent to the RSO for approval. If approved, the RSO will send a supplementary Radioisotope Usage and Disposal Log Sheet to the transferee. The transfer must be reflected on the transferor's Radioisotope Usage and Disposal Log Sheet and on the quarterly inventories of both APIs concerned.
- b. Shipment or transfer of radioactive material from the University must be approved in advance by the RSO and will be coordinated by the RSO.

#### **4.10 PROTECTION PRINCIPLES.**

The purpose of radiation protection measures is to reduce exposure to radiation to as low as reasonably achievable (ALARA), and to ensure that these levels are below the permissible levels as given in Appendix 9.9, and the maximum Permissible Body Burden. These requirements may be fulfilled by applying the basic principles of radiation protection.

- a. Keep the time of exposure to a minimum.
- b. Keep human tissue at as great a distance from the radiation source as is practical.
- c. Keep adequate shielding material between the source and human tissue.
- d. Prevent ingestion, inhalation or transcutaneous absorption of radioactive materials.

These principles are achieved by good housekeeping, good work habits, and by laboratory operations with proper equipment for the handling of radioisotopes, i.e., protective coverings, manipulating devices, suitable ventilation, waste disposal facilities, survey meters, etc. Some of the equipment relies on periodic calibrations such as annually for survey meters. In order to ensure that such equipment is maintained as required by State Regulation or as recommended by the manufacturer, the RSO will maintain a registry of equipment and will facilitate calibrations and maintenance of that equipment. Appendix 9.13 is the registration form for survey meters.

#### **4.11 RADIOISOTOPE LABORATORIES.**

a. **Requirements for Radioisotope Laboratories.**

Of particular importance in the review of the "Application for Authorization to Use Radioactive Materials at Kansas State University" (Form RSC-1) is the suitability of the laboratory area where the work is to be performed. No single set of standards can be established, since the quantity of activity, the isotope(s), the chemical form(s), and the handling and processing to be performed may affect the laboratory design and equipment necessary to meet safety standards. Long range problems must also be considered where longer-lived isotopes are used. It is a policy of the Committee to consider experimental interference as well as health-safety hazards when reviewing authorization applications.

In evaluating the suitability of laboratory space, location, sewer system, sinks, work bench surfaces, wall surfaces, ventilation, and floor covering are pertinent considerations. Special facilities such as hoods or dry boxes will also require careful consideration, particularly as to design and efficiency of function.

While the specific project concerned is paramount in determining laboratory requirements, some features are desirable in almost every case. Where the radioactive material is an unsealed source, an area which can be easily cleaned in the event of a spill is almost always necessary even for many of the shorter-lived isotopes. Porous work surfaces, walls, and floors seldom meet this requirement. The use of trays and absorbent paper as "spill catchers" is helpful, but more is needed in the covering of floors. It is strongly recommended that all radioisotope laboratories in which non-sealed sources of radioactive materials in quantities above "low level activity" (see Appendix 9.3) are handled should have impervious floor covering of a semi-permanent or temporary nature.

Fume hood requirements for radioisotope work are given in Appendix 9.4. Filters in hoods may be required in some instances. Assuming the capsule with the largest single source of radioactive material in your possession spills, the quantity of air moved by the hood system must be sufficient to dilute that amount to below the maximum permissible concentration as listed in Kansas Radiation Protection Regulations. This concentration may be averaged over a period of one year. If this criterion cannot be met, absolute filters or monitoring devices may be required.

Hold-up tanks in the sewer system may be required in some cases. The Committee will decide this when it reviews the authorization application.

Renovation of old facilities for radioisotope work is often difficult. In building new facilities, desirable features for radioisotope or radiation producing equipment facilities can be incorporated more efficiently. The RSC and the Department of Environmental Health and Safety are available to consult with concerned persons about isotope facilities in new buildings. In order to be of value, these groups should be contacted during the early stages of planning.

b. **Rules Pertaining to Radioisotope Laboratories.**

The following rules are guidelines which should be followed. The RSO may grant exemptions or impose more stringent rules as individual cases warrant.

- 1) To ensure adequate planning, before an experiment is performed, the worker must determine the types and amount of radiation or radioactive material to be used, and how it will be disposed. This will generally give a good indication of the amount of protection required. The experimental procedure for each project must be well outlined. When feasible, before the experiment is actually performed with radiation, it should be rehearsed so as to preclude unexpected complications or deviations from schedule.
- 2) Area Monitoring
  - a) Each laboratory using radioactive materials must have available to it some type of calibrated radiation monitoring instrument appropriate for the type of radiation being used.
  - b) Areas in which radioisotopes other than sealed sources are being used shall be checked for contamination routinely (at the end of every experiment or at the end of the day if the experiment is continuing). Any contamination observed shall be reported to the API and the RSO.
  - c) In addition to the routine checks designated above, these areas will be inspected each time there is reason to suspect contamination.
  - d) Air monitoring may be required in some cases. The recommendations of the RSO regarding the necessity of air monitoring equipment and the mode and

- frequency of its use in such applications shall be binding.
- 3) Do not use tobacco products, eat, drink, or apply cosmetics in radioisotope laboratories (this includes gum, candy, and bottled water).
  - 4) Do not bring food containers into radioisotope laboratories. Refrigerators must not be used jointly for food and radioactive materials. The placement of office desks in the laboratory is discouraged.
  - 5) Keep fingernails clean and short.
  - 6) Do not pipette by mouth. Use rubber bulbs, syringes, or mechanical devices for pipetting.
  - 7) Wash hands and arms thoroughly before handling any object which goes to the mouth, nose, or eyes (e.g., food, cigarettes, cosmetics, etc.).
  - 8) Keep or transport material in such a manner as to prevent breakage or spillage: double containers are recommended.
  - 9) Never perform work with volatile radioisotopes outside exhaust hoods or glove boxes until serious consideration has established the safety of doing so. If original authorization required work to be done in hood or glove box, RSO approval must be received before work can be done outside these areas.
  - 10) Vacuum pumps used in systems containing radioisotopes must not be permitted to exhaust into room air. Suitable traps must be incorporated into vacuum lines (including those utilizing water aspirators).
  - 11) Keep laboratory neat and clean. The work area should be free from equipment and material not required for the immediate procedure.
  - 12) Protective Clothing.
    - a) The RSO may require the use of protective clothing.
    - b) Most radioisotope work approved at the University is of such a nature, and levels of radiation will be low enough that ordinary laboratory coats and protective gloves will be adequate protective clothing. It is particularly important that protective gloves be worn if there is a break in the skin below the wrist.
  - 13) To prevent permanent contamination of working surfaces, use one or more of the following items on top of the working surface: stainless steel, plastic, or glass trays; glass, absorbent paper, strippable paint, or plastic film. The RSO has the authority to require floors to be waxed in order to make them more impervious to radioactive material.
  - 14) Be your own monitor. Each worker is responsible for monitoring his/her hands, clothing, shoes or any other parts that may be contaminated. Hand checks are mandatory before leaving the work area for lunch or at the end of the work day. Decontamination must be done whenever contamination of the skin or clothing exists. Experimenters are invited to call the RSO for advice and/or assistance at any time.
  - 15) Always wear the assigned personnel radiation monitoring devices when working in the radioisotope laboratories and any other time when there is a possible radiation exposure.
  - 16) Keep contaminated waste in a container which is used only for waste radioactive materials (See Section 4.15).

c. **Rules Pertaining to Laboratories Possessing and Using Transuranic Elements.**

The elements in the transuranic series are highly radiotoxic and must be handled with extreme caution. Special monitoring equipment and handling devices must be available and function in laboratories where unsealed radioactive sources of this series are handled. The minimum special equipment required includes:

- 1) An alpha-sensitive air particulate monitor.
- 2) A suitable glove box.
- 3) An alpha survey meter.
- 4) A fume hood that contains a NRC approved absolute filter and has an air flow of at least 125 linear feet per minute face velocity with the hood door open to its fullest extent.

Alpha sensitive urinalyses will be required for experimenters utilizing unsealed transuranic elements unless API can defend an exemption request. Urinalysis will be performed by a commercial vendor.

The radiotoxicity of the transuranic elements as compared to some other common isotopes as indicated by the limiting Derived Air Concentration (DAC) is found in Appendix 9.5.

## 4.12 ACCIDENT PROCEDURES.

In the event of an accident (spill, ingestion, over-exposure, etc.), notify the Radiation Safety Officer at (785) 532-5856 during regular business hours as promptly as possible without causing excessive exposure or spreading of contamination. After hours, notify the University Police (785) 532-6412 as promptly as possible and ask that the Radiation Safety Officer be notified.

After notification (or if notification cannot be made), the corrective procedures below should be started pending the arrival of the Radiation Safety Officer:

a. **Personnel contamination** should be treated as follows:

- 1) Remove all contaminated clothing.
- 2) Immediately flush any possible contaminated cuts with running water.
- 3) Attempt to wash off any contamination on the skin.
- 4) It may be wise to induce vomiting in an individual who has or may have ingested radioactive material. It is well to remember that many radioactive materials may also be chemically poisonous.

b. If **area contamination** exists, the following steps should be taken to limit spread of contamination:

- 1) The area should be immediately closed to all personnel except those necessary to cope with the contamination. Signs should be conspicuously placed if the area is not going to be directly watched.
- 2) No one should be allowed to leave the area with contaminated footwear unless removal of footwear will involve an even greater hazard.

- 3) Immediate steps should be taken to prevent the spread of contamination by absorbing or restraining the flow of liquid contaminants or taking steps to decrease the spread of dust. Be sure you know the pertinent chemical and physical properties (solubility, volatility, etc.) of the contaminant before attempting to remove it.  
Unnecessary spreading of contamination may otherwise occur.
  - 4) If airborne contamination is possible or probable, personnel should hold their breath or cover their mouth and nose with a wet cloth and shut all windows and doors before leaving the area. Central air conditioning, hot air heat, or ventilation equipment should be shut down immediately. However, any properly filtered hoods or special ventilating equipment required by the project should be left running. Window type air conditioners should be turned off.
- c. **Decontamination.** Usually the person responsible for the incident should perform the major portion of decontamination under the supervision of the RSO. After any but the most trivial accident, the user should send the RSO a written report describing the incident, to include decontamination performed, any action taken with regard to personnel involved, and steps taken to prevent the recurrence of a similar incident.
  - d. The RSO shall be responsible for reporting the incident to the KDHE, Bureau of Community Health Systems, Radiation Control Program.

#### 4.13 POSTING.

- a. Areas or containers in which radioisotopes are located, stored, or being used shall be posted with appropriate radioactive materials or radiation warning signs as described in Appendix 9.8. Note: No other areas or containers shall be labeled with any type of a radiation warning sign.
- b. A KDHE form RH-3 (Notice to Employees) will be posted in or near every radioisotope laboratory.
- c. Radioactive materials or radiation warning signs should not be disposed of by normal trash unless defaced.
- d. Do not deface posted radioactive materials or radiation warning signs.

#### 4.14 STORAGE OF RADIOISOTOPES AND EQUIPMENT.

- a. **Radioisotopes.** Containers in which radioactive material is stored shall have a firmly affixed durable, clearly visible label bearing the radiation symbol and words CAUTION (or DANGER) RADIOACTIVE MATERIAL. Labels on storage containers shall also state the quantities and kinds of radioactive materials and date of measurement. Stored radioactive material should be kept in a locked container within a locked room. Reasonable protection shall be provided against loss or leakage by the effects of fire or water.
- b. **Equipment.** Equipment such as glassware used for radioactive material shall be kept separate from other equipment. Once used with radioisotopes, the equipment shall not be used for other work or shall not be sent to the repair or glass shop until demonstrated to be free of contamination. A storage cabinet marked with an official radiation symbol should be provided for glassware and tools used in radioisotope work.

## 4.15 DISPOSAL OF RADIOACTIVE WASTES.

The RSO will pick-up and properly dispose of radioactive waste produced on campus. During the normal course of experimentation, low levels of radioactive materials may necessarily be released to the sanitary sewer. The bulk of radioactive waste material, however, should be collected for later pick-up. Instructions as to proper collection and storage of radioactive waste before pick-up are given below.

- a. Separate waste by Isotope and Type:
  - 1.) Separate solid from liquid. Vials containing liquid are not acceptable.
  - 2.) Separate aqueous liquid from organic solvent samples.
  - 3.) Separate by isotope.
    - a).  $^{14}\text{C}$  and  $^3\text{H}$  may be stored together.
    - b). Isotopes with half-lives of 30 days or less may be stored together ( $^{32}\text{P}$ ,  $^{51}\text{Cr}$ ,  $^{86}\text{Rb}$ , etc.).
    - c). Other isotopes must be individually stored.
- b. Scintillation Fluid: It is required that biodegradable, aqueous type fluors are used to count samples on liquid scintillation counters.
  - 1.) Pour used scintillation fluid from vials into collection container (i.e., gallon jug).
  - 2.) Rinse vials with water and dispose in the regular trash.
- c. Waste Containers:
  - 1.) All containers for waste must be labeled with the radioactive waste sticker provided by the RSO. When the container is ready for disposal, the date and amount of isotope contained must be added.
  - 2.) All containers must remain closed except when adding waste.
  - 3.) Solid waste containers:
    - a). Must be hard-sided, such as a cardboard box.
    - b). Must be lined with a plastic bag.
    - c). Must have a closeable lid.
  - 4.) Liquid waste containers: Be sure jar is designed to hold liquids. Do not use any container that did not originally contain liquid.
    - a). Quart size or larger only.
    - b). Do not fill completely full. Leave at least 1" headspace for small jars and 3" headspace for larger jars.
    - c). Must have lid that seals securely and does not leak.
- d. Pick-up:
  - 1.) Notify Environmental Health & Safety for radioactive waste pickup. Either use the EH&S web site ([www.k-state.edu/safety](http://www.k-state.edu/safety)) or call EH&S at 2-5856. If special arrangements need to be made, contact the RSO.
  - 2.) When the original source container is to be disposed, be sure to return the Radioisotope Receipt and Disposal Log to the RSO.

- 3.) Waste which is not properly packaged and labeled will not be picked up.
- 4.) If your waste is also considered hazardous as defined in the Good Laboratory Safety Practices Manual, call the Department of Environmental Health and Safety at 2-5856 to request a hazardous waste pick-up.

#### **4.16 RULES PERTAINING TO SEALED SOURCES.**

a. General.

- 1) Sealed sources may be approved for use in rooms other than those designated and regulated by section 4.9 above as radioisotope laboratories.
- 2) If questions should arise concerning the classification of a source as sealed or unsealed, the RSO shall have the ultimate authority in classifying the particular source. Normally, the quality or degree of reliability of encapsulation will be evaluated upon submission of Form RSC-1 for use of a sealed source.

b. Leak Testing.

- 1) Unless otherwise specified by the RSO, all licensed beta-gamma sealed sources shall be checked for leakage at least once every six (6) months and all licensed sealed sources which are designed to permit the escape of alpha particles shall be checked for the integrity of containment at least once every three (3) months. This test will be conducted by the RSO. If the wipe test indicates the presence of 0.005 microcuries or more of removable contamination, the source shall be considered leaking. Any sealed source that is leaking may not be used again until the source is decontaminated and/or repaired. If a source is detected leaking, notify the RSO immediately. Results of the leak tests will be maintained by the RSO.
- 2) Care must be exercised to avoid undue mechanical or thermal shock to sealed sources. If such shock should occur, the encapsulation shall be checked for integrity and a wipe test made. If there is any question about the integrity of the capsule, the RSO must be notified promptly.
- 3) To minimize the consequences of rupture of a sealed source, such sources should not come in direct contact with the user. As a minimum, the last object coming into contact with a sealed source prior to the source being returned to its normal storage should be checked for contamination.

c. Radiographic Sources.

Sources of radiation used for industrial radiography require special attention. (See Kansas Radiation Protection Regulations - Part 7 - Special Requirements for Industrial Radiographic Operations). Authorization applications (Form RSC-1) to accommodate use of radiographic sources must be accompanied by a set of proposed administrative, operating, and emergency procedures governing the use and care of such a radiographic source. The application along with the required procedures shall be submitted to the Radiation Safety Committee, through its Chair, for recommendations and/or approval. Applicants are urged to consult with the RSO for advice in preparation of authorization applications and procedures.

## **5.0 NUCLEAR REACTORS**

Insofar as a nuclear reactor both produces radioisotopes and is a radiation source, the Radiation Safety Officer has the authority and obligation to restrict the operations of any such reactor at the University to ensure that such operations shall be in compliance with all appropriate laws and regulations regarding radiation protection.



## **6.0 RADIATION PRODUCING DEVICES**

All radiation producing devices (particle accelerators, X-ray machines, X-ray diffractometers, etc.) must be registered with the RSO. The RSO will determine if the machines are housed and operated so that the radiation exposures are at a minimum consistent with their operation. The results of his/her findings shall be maintained for inspection by the regulatory agencies.

### **6.1 REQUIREMENTS FOR ANALYTICAL X-RAY EQUIPMENT.**

- a. Safety Device. All equipment with an open-beam configuration shall have a device which prevents the entry of any portion of an individual's body into the primary X-ray beam path or which causes the beam to be shut off upon entry into its path.
- b. Warning Devices. Warning devices shall be labeled so that their purpose is easily identified. Open-beam configurations shall be provided with a readily discernible indication of:
  - 1) X-ray tube status (on-off) located near the radiation source housing if the primary beam is controlled in this manner; and/or
  - 2) Shutter status (open-closed) located near each port on the radiation source housing if the primary beam is controlled in this manner.
- c. Ports. Unused ports on radiation source housings shall be secured in the closed position such as to prevent casual opening.
- d. Labeling. All analytical X-ray equipment must be labeled with a sign or signs bearing the radiation symbol and the words: "CAUTION - HIGH INTENSITY X-RAY BEAM", or words having a similar intent on the X-ray source housing; and, "CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED", near any switch that energizes an X-ray tube.
- e. Warning Lights. An easily visible warning light labeled with the word "X-RAY ON", or words having a similar intent, shall be located near any switch that energizes an X-ray tube and shall be illuminated only when the tube is energized.
- f. Bypassing. No person shall bypass a safety device unless such person has obtained the written approval of the RSO.
- g. Instructions. All persons operating analytical X-ray equipment shall be properly instructed in the operation and radiation safety hazards inherent in X-ray units.

### **6.2 REQUIREMENTS FOR PARTICLE ACCELERATORS.**

- a. All entrances into a target room or other high radiation area (100 mr/hr or higher) shall be provided with interlocks that shut down the machine or reduce the radiation level to less than 50 mr/hr under conditions of barrier penetration.
- b. When an interlock system has been tripped, it shall only be possible to resume operation of

the accelerator by manually resetting controls at the position where the interlock has been tripped, and lastly at the main control console.

- c. Each safety interlock shall be on a circuit which shall allow its operation independently of all other safety interlocks.
- d. All safety interlocks shall be fail safe, i.e., designed so that any defect or component failure in the interlock system prevents operation of the accelerator.
- e. A scram button or other emergency power cutoff switch shall be located and easily identifiable in all high radiation areas. Such a switch shall include a manual reset so that the accelerator cannot be restarted from the accelerator control console without resetting the cutoff switch.
- f. All locations designated as high radiation areas and entrances to such locations shall be equipped with easily observable flashing or rotating lights that operate when, and only when, radiation is being produced.
- g. Each high radiation area shall have an audible or visible warning device which shall be activated for fifteen (15) seconds prior to the possible creation of such high radiation area. Such warning devices shall be clearly discernible in all radiation areas.
- h. All safety and warning devices, including interlocks, shall be checked for proper operability at least once every three (3) months. Results of such tests shall be maintained.
- i. If, for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action must be authorized by the Radiation Safety Committee and/or the RSO. The bypass action must be recorded in a permanent log and a notice posted at the accelerator control console.
- j. All area monitors and portable survey meters must be calibrated annually.

## 7.0 PERSONNEL MONITORING

A number of devices and methods exist for assessing an individual's exposure to ionizing radiation. Whether or not one or more of these monitoring methods is employed for a given situation will depend upon a number of factors (e.g. type and quantity of radioactive material used, amount of time spent working with the material, etc.) which together determine the particular exposure potential.

### 7.1 PERSONNEL DOSIMETRY.

- a. Kansas regulations require personnel dosimetry for individuals expected to receive, in one year from sources external to the body, a dose in excess of 10% of the annual permitted dose (given in Appendix 9.9). Personnel dosimetry monitoring equipment shall consist of film badges, pocket ionization chambers (PICs), thermoluminescent dosimeters (TLDs), optically stimulated luminescence dosimeters (OSLs), etc. Anyone who requests personnel dosimetry shall receive it regardless of likelihood to receive a dose in excess of 10% of the limits.
- b. Radiation doses received by Kansas State University personnel when visiting other installations should be reported to the RSO for inclusion in individual cumulative exposure records.
- c. A special situation arises when an occupationally exposed woman is pregnant. Exposure of the abdomen of such a worker to penetrating radiation from either external or internal sources would also involve exposure of the embryo or fetus. Because a number of studies have indicated that the embryo or fetus is more sensitive than an adult, particularly during the first three months after conception when a woman may not be aware that she is pregnant, it is required that precautions be taken to limit exposure when an occupationally exposed woman could be pregnant. The normal guideline of 5 rems per calendar year for occupational workers shall not apply to fertile women. Considering the Federal regulation that a 0.5 rem dose to a fetus is acceptable, the following procedures will be followed.
  - 1) Women of reproductive age should limit their occupational exposure to the abdomen area to 0.7 rem per calendar quarter, thus corresponding to an even rate distribution of less than 3 rems per year.
  - 2) Women in a condition of the first signs of pregnancy shall limit their occupational exposure to the abdomen area to less than 0.5 rem over the entire pregnancy period.
  - 3) Any women contemplating pregnancy or under knowledge of the first signs of pregnancy, should contact her administrative supervisor.
  - 4) Pregnant women have the right to choose to disclose or not disclose their status. The "Declaration of Pregnancy for Laboratory Workers" (See Appendix 9.7) should be completed and submitted to the RSO as early as possible.
- d. Personnel dosimeters (film badges, TLDs, OSDs) may be obtained from the Department of Environmental Health and Safety after the individual completes the "Personnel Radiation Monitoring Service Request Form" (See Appendix 9.6). The form is required by regulatory agencies in order to maintain radiation exposure histories of radiation workers.

- e. Individuals must return radiation monitoring dosimeters to the Department of Environmental Health and Safety if leaving the University or if no longer a radiation worker on campus. The API has the responsibility to ensure the return of all dosimeters used by individuals under his/her direction.

## **7.2 BIOASSAYS.**

Although the likelihood of internal exposure is minimal, bioassays may be required if experimentation requires either large quantities of unsealed isotopes in a single procedure or produces (or may produce) aerosols or vapors of radioisotopes.

- a. Urinalysis may be required of individuals using large quantities (>100 mCi) of low energy beta emitters (e.g.  $^3\text{H}$ ,  $^{14}\text{C}$ ) in a single experiment, or other isotopes as deemed necessary by the RSO.
- b. Thyroid scans may be required of personnel working in a laboratory in which radioiodine is used in forms other than Radioimmunoassay (RIA) Kits.

## **7.3 PERSONNEL EXPOSURE RECORDS.**

The result of all personnel monitoring performed for individuals working with ionizing radiation at Kansas State University are maintained on file by the RSO, Department of Environmental Health and Safety. Each individual's exposure records are available to him/her upon request. An individual will be notified immediately by the RSO should he/she have a current monitoring result which appears to be excessive. Regulatory limits of exposure may be found in Appendix 9.9.

## **8.0 MISCELLANEOUS**

1. Adequate precautions must be taken to prevent unauthorized personnel from tampering with any source of radiation.
2. The RSO will provide for each interested department a list of qualified persons who may be contacted if he/she or the Assistant RSO is not available in an emergency.
3. The forms referred to in this manual are also available from the Department of Environmental Health and Safety, Radiation Safety Office.

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# APPENDIX 9.1

Form RSC-1 09/2018	<b>APPLICATION FOR AUTHORIZATION TO USE RADIOACTIVE MATERIALS AT KANSAS STATE UNIVERSITY</b>	
Submit two originals: Department of Environmental Health and Safety, 135 Dykstra Hall		
<ul style="list-style-type: none"> <li>• All requisitions for the purchase or procurement of radioisotopes must be directed to and approved by the Radiation Safety Officer.</li> <li>• The Radiation Safety Officer will be the recipient of <u>all</u> radioisotopes ordered in order to open package and check for contamination.</li> <li>• Each approved application is valid only for the user, radioisotope(s), millicurie amounts, use, and location until December 15<sup>th</sup> of each year.</li> </ul>		
<p>The following information is necessary for issuance of authorization for possession or use of radioactive materials. Under the Privacy Act of 1974, all data of a private nature must be protected from unauthorized disclosure. Section 1163 of Title 5 of the U.S. Code authorizes collection of this information. The primary use of this information is for tracking occupational doses of ionizing radiation and verification of safety training as required by Kansas Administrative Regulations 28-35. Collection of this information, including your social security number is authorized by K.A.R. 28-25-230a and 28-35-334. Furnishing the information on the form is voluntary, but failure to do so may result in disapproval of use of radioactive materials or devices or denial of access to labs where radioactive materials or devices are used. <b>Complete all fields of this form.</b> Please type or print legibly in black ink.</p>		
Name:	Title:	eID
Department:	Office:	Phone ( )
List the labs/locations where the radioisotopes will be used:		
List experience and training in the use of radioisotopes:		
List name, department, classification (student, assistant, etc.), and phone number of individuals who will be using radioactive materials under your supervision (attach separate sheet if necessary).		
<b>Radioactive Material(s):</b> (List chemical symbol and mass number of each isotope requested.)	<b>Chemical/Physical Form:</b> (List Manufacturer & model number if sealed source)	<b>Possession Limit:</b> (Maximum amount of millicuries you will possess at any time. Include your post experiment by-product in the estimate)

What survey instrument is available for your use? Include the make, model, serial number, and range of detection (0-100 mR/hr, or cpm, etc.)?

Proposed Use: (Give sufficient detail concerning the problem and methods of use of the radioactive material(s) to provide a basis for the general evaluation of the health hazards and possible building contamination)

Laboratory Radiation Protection Plan: (List procedures and equipment to be used to limit exposure of personnel to As Low As Reasonably Achievable)

Signature of Applicant \_\_\_\_\_ Date \_\_\_\_\_

Signature of Approval by the  
Radiation Safety Committee \_\_\_\_\_ Date \_\_\_\_\_

Title: \_\_\_\_\_





## APPENDIX 9.3

## RADIOTOXICITY GROUPS

	Activity Limits		
	Low	Medium	High
<b>Low Hazard</b> <sup>3</sup> H, <sup>7</sup> Be, <sup>14</sup> C, <sup>19</sup> F, <sup>59</sup> Ni, <sup>69</sup> Zn, <sup>71</sup> Ge, <sup>238</sup> U, Natural Thorium, Natural Uranium, Noble gases	Up to 5 mCi	5 mCi to 5 Ci	Above 5 Ci
<b>Medium Hazard</b> <sup>24</sup> Na, <sup>31</sup> Si, <sup>32</sup> P, <sup>33</sup> P, <sup>35</sup> S, <sup>36</sup> Cl, <sup>42</sup> K, <sup>47</sup> Sc, <sup>49</sup> V, <sup>51</sup> Cr, <sup>54</sup> Mn, <sup>56</sup> Mn, <sup>55</sup> Fe, <sup>59</sup> Fe, <sup>64</sup> Cu, <sup>65</sup> Zn, <sup>72</sup> Ga, <sup>76</sup> As, <sup>86</sup> Rb, <sup>89</sup> Ar, <sup>90</sup> Y, <sup>91</sup> Y, <sup>95</sup> Zr, <sup>95</sup> Nb, <sup>99</sup> Mo, <sup>103</sup> Ru, <sup>103</sup> Pd, <sup>105</sup> Rh, <sup>105</sup> Ag, <sup>109</sup> Cd, <sup>111</sup> Ag, <sup>113</sup> Sn, <sup>127</sup> Te, <sup>129m</sup> Te, <sup>140</sup> Ba, <sup>140</sup> La, <sup>143</sup> Pr, <sup>147</sup> Pm, <sup>151</sup> Sm, <sup>166</sup> Ho, <sup>170</sup> Tm, <sup>177</sup> Lu, <sup>183</sup> Re, <sup>190</sup> Ir, <sup>192</sup> Ir, <sup>191</sup> Pt, <sup>193</sup> Pt, <sup>196</sup> Au, <sup>198</sup> Au, <sup>199</sup> Au, <sup>200</sup> Tl, <sup>201</sup> Tl, <sup>202</sup> Tl, <sup>204</sup> Tl, <sup>203</sup> Pb, <sup>220</sup> Rn, <sup>222</sup> Rn, <sup>235</sup> U	Up to 2 mCi	2 mCi to 100 mCi	Above 100 mCi
<b>High Hazard</b> <sup>22</sup> Na, <sup>45</sup> Ca, <sup>46</sup> Sc, <sup>60</sup> Co, <sup>106</sup> Ru, <sup>125</sup> I, <sup>129</sup> I, <sup>131</sup> I, <sup>137</sup> Cs, <sup>144</sup> Ce, <sup>154</sup> Eu, <sup>182</sup> Ta, <sup>210</sup> Bi, <sup>211</sup> At, <sup>224</sup> Ra, <sup>233</sup> U	Up to 1 mCi	1 mCi to 20 mCi	Above 20 mCi
<b>Very High Hazard</b> <sup>210</sup> Pb, <sup>210</sup> Po, <sup>226</sup> Ra, <sup>228</sup> Ra, <sup>227</sup> Ac, <sup>228</sup> Th, <sup>230</sup> Th, <sup>237</sup> Np, <sup>238</sup> Pu, <sup>239</sup> Pu, <sup>240</sup> Pu, <sup>241</sup> Pu, <sup>242</sup> Pu, <sup>241</sup> Am, <sup>242</sup> Cm	Up to 0.5 mCi	0.5 mCi to 5 mCi	Above 5 mCi

The Radiation Safety Committee will be called upon to approve requests for Radioisotope Authorizations in the medium and high activity limits categories. The Radiation Safety Officer is authorized to tentatively approve authorizations in the low limit category pending consideration for full approval by the Radiation Safety Committee at its next meeting.

## APPENDIX 9.4 BASIC PERFORMANCE CRITERIA FOR LABORATORY HOODS

The following may be used as a general guide for the selection of hood blower exhaust systems that will provide optimum average face velocities for various exhaust materials.

Very low toxicity level material Noxious odors, nuisance dusts and fumes	80 FPM
General Lab Use Corrosive Material Moderate toxicity level material (TLV of 10-1000 ppm) <b>Tracer quantities of radioisotopes</b>	100 FPM
Higher toxicity level material (TLV less than 10 ppm) <b>Use of radioisotopes, iodination</b>	125-150 FPM
Pathogenic Microorganisms <b>High alpha or beta emitters</b> Very high toxicity level material (TLV less than 0.01 ppm)	An enclosed glove box should be used

## APPENDIX 9.5      DERIVED AIR CONCENTRATIONS (DAC) FOR SELECTED ISOTOPES

Isotope	DAC ( $\mu\text{Ci/cc}$ )	$T_2$
$^{252}\text{Cf}$	$8 \times 10^{-12}$	2.55 y
$^{243}\text{Cm}$	$4 \times 10^{-12}$	32 y
$^{235}\text{U}$	$6 \times 10^{-10}$	$7.13 \times 10^8$ y
$^{241}\text{Am}$	$3 \times 10^{-12}$	458 y
$^{237}\text{Np}$	$2 \times 10^{-12}$	$2.14 \times 10^6$ y
$^{239}\text{Pu}$	$3 \times 10^{-12}$	$2.44 \times 10^3$ y
$^{242}\text{Pu}$	$3 \times 10^{-12}$	13 y
$^3\text{H}$	$2 \times 10^{-5}$	12.8 y
$^{14}\text{C}$	$1 \times 10^{-6}$	5600 y
$^{32}\text{P}$	$4 \times 10^{-7}$	14.3 d

The following information is necessary for initiation of Personnel Radiation Monitoring Service. Under the Privacy Act of 1974, all data of a private nature must be protected from unauthorized disclosure. Section 1163 of Title 5 of the U.S. Code authorizes collection of this information. The primary use of this information is for tracking occupational doses of ionizing radiation and verification of safety training as required by Kansas Administrative Regulations 28-35. Collection of this information, including your social security number is authorized by K.A.R. 28-25-230a and 28-35-334. Furnishing the information on the form is voluntary, but failure to do so may result in disapproval of use of radioactive materials or devices or denial of access to labs where radioactive materials or devices are used. Complete all fields of this form. Please type or print legibly in black ink.

FULL NAME: Last First Middle University eID

SSN DATE OF BIRTH: mm dd yyyy SEX: M F (circle one)

MANHATTAN ADDRESS: Phone

PERMANENT ADDRESS: (where final results can be sent)

DEPARTMENT: LAB (Building & Room #):

SUPERVISING PROFESSOR:

REQUESTED DOSIMETRY: Badge Ring (right hand) Ring (left hand)

- Are you regular lab worker soil moisture probe user Lafene Radiology VHC Staff VHC Senior Student VHC radiology Reactor worker MNE Staff or Student Physics Staff or student Other

By signing below I certify that the above information is true and correct and I authorize the release of all my radiation exposure history to the Department of Environmental Health and Safety, Kansas State University. I acknowledge that copies of this request form are valid.

SIGNATURE: DATE:

Personnel monitoring was provided for me previously at the following institutions. If none, indicate NONE. Write additional institutions on the back of the form.

Institution: Department:

Address: Monitoring period: from to

## APPENDIX 9.7 Declaration of Pregnancy for Laboratory Worker

**Kansas State University  
Department of Environmental Health and Safety  
135 Dykstra Hall, 1628 Claflin Road, Manhattan, KS 66506-0900**

Please enter information in all fields and send form to the Radiation Safety Officer at the above address.

NAME: \_\_\_\_\_ SSN#: \_\_\_\_\_

Authorized Principal Investigator/Lab Supervisor: \_\_\_\_\_

Approximate Date of Conception (or Due Date, if unknown): \_\_\_\_\_

Do you wish this notice be kept confidential for the present?     Yes     No

You will be contacted by the Radiation Safety Officer in a few days to address any concerns and discuss any special procedures or modifications in dosimetry or bioassay monitoring that may be required. Please call the RSO at 532-5856 if you have not been contacted within two weeks. This declaration may be withdrawn at any time without explanation.

### PRIVACY ACT INFORMATION

Under the Privacy Act of 1974, all data of a private nature must be protected from unauthorized disclosure. Section 1163 of Title 5 of the U.S. Code authorizes collection of this information. The primary use of this information is for tracking occupational doses of ionizing radiation as required by Kansas Administrative Regulations 28-35. Collection of this information, including your social security number is authorized by K.A.R. 28-25-230a and 28-35-334. Furnishing the information on the form is voluntary, but failure to do so may result in disapproval of use of radioactive materials or devices.

List the isotopes or radiation devices and activities you are working with or anticipate working with during your pregnancy (isotope, maximum mCi per day, maximum mCi per month, etc.)

By signing below, I indicate that I understand the exposure of my unborn child from occupational exposure to ionizing radiation will not be allowed to exceed 500 mrem during the entire pregnancy. I also understand that this limit includes any exposure I have received since conception, and that if the dose to my unborn child has already exceeded 500 mrem, the dose for the remainder of my pregnancy shall be limited to 50 mrem. I further understand that if I should find out I am not pregnant, or if for any reason my pregnancy is terminated, I should inform my supervisor and/or the Radiation Safety Officer as soon as possible.

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

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

## APPENDIX 9.8 WARNING SIGNS

The radiation symbols prescribed shall be the conventional three-bladed design. The blades and center shall be magenta or purple and the background yellow.

The following signs bearing the radiation symbol, and the following words shall be posted in occupiable areas.

- |     |  |  |
|-----|--|--|
| (1) | CAUTION<br>RADIATION AREA              | if such area is a radiation area;  |
| (2) | CAUTION<br>HIGH RADIATION AREA         | if such area is a high radiation area;   |
| (3) | CAUTION<br>VERY HIGH RADIATION AREA    | if such area is a very high radiation area;  |
| (4) | CAUTION<br>AIRBORNE RADIOACTIVITY AREA | if such area is an airborne radioactivity area;  |
| (5) | CAUTION<br>RADIOACTIVE MATERIAL        | if there is used or stored in such area more than 5 millicuries of natural thorium or uranium, or more than ten times the generally licensed quantity of any radioactive material. |
| (6) | CAUTION<br>X-RAY                       | if such area contains as the only source of radiation, permanently installed X-ray machine or machines.  |

For definitions of "Radiation Area", "High Radiation Area", "Very High Radiation Area", and "Airborne Radioactivity Area" see Kansas Radiation Protection Regulations.

## APPENDIX 9.9 EXPOSURE LIMITS

<u>Body Portion</u>	<u>Annual Dose Limit</u>
Whole Body	5.0 rem (TEDE)
Lens of Eye	15.0 rem (LDE)
Extremities	50.0 rem (SDE)
Skin	50.0 rem (SDE)
Other Organs	50.0 rem (TODE)
Embryo/Fetus	0.5 rem (gestation) (DDE & IDE)

### Radiation Dose Terms

TEDE:	Total effective dose equivalent (DDE + CEDE)
LDE:	Lens of eye dose equivalent (DE @ 0.3 cm depth)
SDE:	Shallow dose equivalent (DE @ 0.007 cm depth)
TODE:	Total organ dose equivalent (DDE + CDE)
DDE:	Deep dose equivalent (DE @ 1 cm depth)
CEDE:	Committed effective dose equivalent
EDE:	Effective dose equivalent
CDE:	Committed dose equivalent
IDE:	Dose equivalent from radionuclides in embryo/fetus in declared pregnant women





**Laboratory Room**  
**number:** \_\_\_\_\_  
**Survey**  
**Date/Time:** \_\_\_\_\_  
**Meter Model**  
**Number:** \_\_\_\_\_  
**Meter Serial**  
**Number:** \_\_\_\_\_

**Laboratory**  
**Supervisor:** \_\_\_\_\_  
**Survey performed**  
**By:** \_\_\_\_\_  
**RSO/ASRO**  
**Check:** \_\_\_\_\_

Please sketch a map of your laboratory below. Include doorways, windows, and any other fixtures that will aid in orienting the map to the lab. Also include counters, refrigerators, fume hoods, and other areas where radioactive materials or waste is used or stored. Designate areas surveyed on the map below and record meter reading in chart provided.



Area Surveyed	Reading (mr/hr or CPM)	Area Surveyed	Reading (mr/hr or CPM)	Area Surveyed	Reading (mr/hr or CPM)



**Kansas State University  
Department of Environmental Health and Safety**

Please complete (1) form for each meter and email (radsafety@ksu.edu), fax (2-1891), or campus mail to Radiation Safety Officer (EH&S, 135 Dykstra Hall).

CONTACT INFORMATION

Authorized Principal Investigator \_\_\_\_\_ Phone \_\_\_\_\_

Title \_\_\_\_\_ Email \_\_\_\_\_

Department \_\_\_\_\_

Building and Room # where meter is located \_\_\_\_\_

SURVEY METER IDENTIFICATION INFORMATION

Meter Manufacturer \_\_\_\_\_

Model Number \_\_\_\_\_ Serial Number \_\_\_\_\_

Date of last calibration or purchase date \_\_\_\_\_

Scale (include multiplier, if any) \_\_\_\_\_

Signature: \_\_\_\_\_ Date \_\_\_\_\_  
Authorized Principal Investigator