

# **HANDBOOK OF RADIOLOGICAL OPERATIONS**

published by the

**RADIATION SAFETY COMMITTEE**

of the

**UNIVERSITY OF MISSOURI-KANSAS CITY**

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## FOREWORD

This Handbook of Radiological Operations (hereinafter, Handbook) is the official guide in all matters relating to radiation protection and control for the University of Missouri-Kansas City (hereinafter, UMKC). It has been prepared by direction of the Radiation Safety Committee (hereinafter, RSC), which serves as the advisory body to the Chancellor, the faculty and the staff of UMKC on matters related to radiation protection and control. The RSC is appointed by the Chancellor and is responsible for establishing policy and guidelines to safeguard personnel, property, and the community-at-large from exposure to hazardous radiations. The responsibilities of the RSC are described in **Section 1.2**.

The Chancellor has appointed a Radiation Safety Officer (hereinafter, RSO) and delegated to the RSO responsibility for and authority over the coordination and the implementation of the radiation safety program. The responsibilities of the RSO are also described in **Section 1.4**.

UMKC has applied for and has been granted a materials license by the U.S. Nuclear Regulatory Commission (hereinafter, NRC) for possession and use of a variety of byproduct materials. It is incumbent upon each person authorized to use a radiation source to become familiar with and to observe the rules and regulations contained herein. Copies of the materials license and the documents related to them are maintained in the Division of Radiation Safety (hereinafter, DRS) of the Office of Chemical, Biological and Radiation Safety (hereinafter, CBARS) where they may be examined.

In its negotiations with the NRC to obtain amendments to extend and enlarge the provisions of the license, UMKC makes specific presentments about how it proposes to safeguard the material to be used. The NRC's license reviewer may request additional information to be supplied before a license amendment can be issued. UMKC must protect itself by limiting its promises to those necessary and reasonable to accomplish the proposed experiment. If the NRC will not accept what is submitted, UMKC must consider whether or not more should be offered, because to do more will cost more and the proposed use may not be worth the extra expense. By this give-and-take exchange, a definition of a "satisfactory level" of radiation control emerges for the specific problem at hand. Note that "satisfactory level" means in this context, a level acceptable to the NRC and a level UMKC can afford to provide.

Thus, a level of radiation safety acceptable to the NRC is provided by UMKC in support of a specific program when, and only when, a determination is made that the merit of the specific program warrants the extra expense of providing the radiation control. In general, the RSC is responsible for the safe use and disposal of radioactive materials in accordance with the procedures contained in this Handbook and consistent with NRC and State of Missouri regulations.

The State of Missouri's Radiation Protection Regulations pertain to all sources of ionizing radiation not covered by the Federal regulations. Since the Federal regulations for safe use of radioactive materials cover only byproduct, source, and special nuclear material, the State regulations are intended to control operation of x-ray machines, naturally occurring and accelerator produced radioactive materials. Because the UMKC regulations have been prepared to cover other radiation sources, no change in the intent of this Handbook is required. However, to comply with the State regulations, UMKC must relate to the Missouri Department of Health in the same way it relates to the NRC.

To perform the tasks necessary to implement UMKC's program of radiation protection and control, the RSC and the administration have arranged for the appointment of a Radiation Safety Officer (RSO) and have delegated to him the responsibility of coordination and implementation of the program on a day-to-day basis.

Regulations adapted from the Federal and State codes and interpreted according to the special needs of UMKC are provided in this Handbook as **Sections 2, 3 and 4**. **Section 2.0** provides the guidelines for safe use of radiation sources in the general research and development applications common to UMKC; **Section 3.0** provides the outline of the inspections to be performed by DRS personnel; and **Section 4.0** provides the instructions for disposal of radioactive wastes.

For the information of those members of the UMKC faculty and staff submitting an application for use of radiation sources for the first time, attention is directed to **Section 5.0**. This section contains the necessary instructions for completing the application forms and details the procedure by which the application is approved. Any questions, not adequately covered by the text, should be directed to DRS, Room 003, 1110 E. 48<sup>th</sup> St., telephone numbers: (816) 235-5289, (816) 235-1844 or (816) 235-1819.

**Section 6.0** outlines radiation safety emergency procedures; **Section 7.0** contains the UMKC policy on unsecured radioactive materials laboratories; **Section 8.0** contains definition of terms and acronyms used in the radiation safety program; **Section 9.0** contains general information that may be helpful in establishing your radiation safety program; and **Section 10.0** contains ordering, receiving and delivering of radioactive materials shipments.

And finally, **Section 11.0** contains forms used in the conduct of the radiation safety program. You may copy these forms for your use.

Because the conditions of use will change with time, it is expected that the rules and regulations will change correspondingly. For this reason, the Handbook has been bound in looseleaf form to facilitate changing single pages as required. The general style of the Handbook is expected to adapt to use as a working document in which the investigator can insert reprints of papers relevant to his own projects and in which he can keep copies of the documents related to his authorization to use radiation sources, such as laboratory survey reports and inventories.

**Note: The text of this document is available on the CBARS Web Site. The web site can be easily accessed through the alphabetical index (departments) section on the UMKC Home Page, under “Chemical, Biological and Radiation Safety.” The URL as of the summer of 2002 is: <http://www.umkc.edu/depts/gfr/cbrs/handbk-docs.html>.**

## **1.0 MANAGEMENT OF RADIATION SAFETY**

### **1.1 DELEGATION OF AUTHORITY**

Responsibility for management of the University of Missouri (hereinafter, University) is vested in the Board of Curators (hereinafter, Board). Executive responsibility and authority for administration of operations within the University, consistent with the policy set by the Board, are delegated to the President. The President, in turn, delegates to the Campus Chancellors the responsibility and the authority for execution of operations conducted on each of the four campuses and to the Vice Presidents the responsibility for administration of distinct sub-elements of the University. Licenses of all types needed by the University are issued to "The Curators of the University of Missouri" (1), and the agent of UMKC in the negotiations to obtain UMKC's materials license is the Chancellor.

The Chancellor is responsible for providing adequate support for the radiation safety operations conducted at UMKC. The Chancellor has delegated this responsibility to the Vice Provost for Research. Whenever this support is not provided adequately or if it cannot be provided, the program of use of radiation sources will be curtailed by the RSC. The RSO will evaluate the radiation safety program and report his findings periodically to the RSC.

Senior management will ensure adequate control over materials licensed activities through the RSC. Senior management may periodically accompany the DRS personnel or the RSO during the performance of their duties, e.g., surveys, inspections and audits of laboratories.

### **1.2 RADIATION SAFETY COMMITTEE**

#### **1.2.1 Membership**

The RSC is constituted in accordance with the Chapter 10 Code of Federal Regulations Part 33 (**10 CFR 33**). Members are appointed by the Chancellor in collaboration with the Vice Provost for Research. The RSC membership includes the RSO, a management representative, and persons trained and experienced in the safe use of radioactive materials. Because the responsibilities of the RSC include more than safe use of radioactive materials, representation from academic disciplines providing expertise in Law, Business Management and Environmental Science, for example, may be sought. The RSC established policies and provides overall guidance for the radiation safety program.

The RSC performs three principal functions:

- Advise the Chancellor on matters relating to radiation safety from all hazardous radiation sources
- Review the performance of the RSO to maintain adequate control of radiation risks and make recommendations to the Chancellor on the continued maintenance of these activities
- Develop and implement the general policy for conduct of experiments or other uses of radiation sources as these uses relate to risk of hazardous exposure to personnel, to property or to the residents of the community in which UMKC conducts its programs.

#### **1.2.2 Responsibilities**

- Perform safety evaluations of all proposed users and uses of radioactive materials and review authorized user permits every three years
- Conduct reviews and audits of the radiation safety program including review of DRS records and procedures, e.g., inventory control, procurement/use, possession limits, exposure reports, waste management, etc.
- Review DRS surveys of authorized users and facilities
- In cooperation with the RSO, develop a Handbook of Radiological Operations, standard operating procedures and criteria for training programs for each category of radiation worker
- Ensure that the ALARA philosophy is being practiced in the conduct of the radiation safety program
- Review results of NRC inspections.



### 1.2.3 Quorum

The RSC conducts business using a two-quorum system. One quorum has been established to review applications for the use of radioactive materials. It consists of at least four members of the RSC including the Chairperson, the RSO, a representative of management and at least one member with expertise in the subject area being reviewed. A quorum to conduct other committee business includes at least five of the nine total members of the RSC, and includes the Chairperson, the RSO and a management representative. Either quorum will meet as often as necessary to conduct the business of the RSC; however, the five member quorum must meet to conduct committee business at least once each calendar quarter.

Applications are submitted to the chairperson of the RSC through the RSO and these applications are reviewed by the procedure outlined in **Section 5.0**. If the application is denied by the RSC, it is returned to the applicant with a statement of the reasons for denial. The applicant can choose to modify the application according to the recommendations of the RSC, drop the application entirely, or appeal the denial to the Chancellor. Upon appeal, the Chancellor has the option of requesting that the RSC reconsider its action upon receipt and evaluation of supplementary information, or can uphold the denial.

The RSC is also responsible for ensuring that radiation safety is maintained adequately on the campus. In its review of applications, the RSC shall determine that radiation safety coverage is available for the use proposed. If radiation safety coverage is not available or cannot be provided, the RSC shall either deny the use or request the campus administration to provide the radiation safety coverage deemed necessary. This is the key step in the review process to ensure that no radiation sources are authorized for use without adequate radiation safety coverage. Also, when previously available radiation safety coverage is lacking, authorizations shall be suspended by the RSC until radiation safety coverage is restored at an acceptable level.

The RSC bears the primary responsibility to maintain all radiation safety matters in compliance. Evidence of a noncompliance must be acted upon promptly, and the cause of the noncompliance must be corrected by action of the RSC.

### 1.2.4 Human-Use Quorum

A human use quorum, if required, will be appointed and act as an advisory body to the RSC in all matters related to safe use of radiation sources in humans. The review of human use applications for radioactive material is required by the Federal regulations. This function is separate and distinct from the role of the Institutional Review Boards required by other Federal regulations for the protection of human subjects, although the Institutional Review Boards may need to be involved as well. The distinction to be made is that the human use quorum reviews all proposed experimental uses in human subjects that could require separate review by the Institutional Review Board. If so directed by the Chancellor, the human use quorum may serve also as the Radioactive Drug Research Committee required by the regulations of the Bureau of Drugs, U.S. Food and Drug Administration for the evaluation of investigational uses of radioactive materials in human subjects.

Applications are submitted to the chairperson of the human use quorum through the RSO and these applications are reviewed by the procedure outlined in **Section 5.0**. If the application is denied by the quorum, it is returned to the applicant with a statement of the reasons for denial. The applicant can choose to modify the application according to the recommendation of the human use quorum, drop the application entirely, or appeal the denial to the Chairperson of the RSC. Upon appeal, the Chairperson may request that the RSC review the action of the human use quorum upon receipt and evaluation of supplementary information, or can uphold the denial. If denied, the applicant can appeal to the Chancellor.

At present UMKC does not use radioactive materials in humans. If and when such use is contemplated, a section for the special conditions of use of radioactive materials in humans will be written and an amendment requested of the NRC for such use.

### 1.2.5 Schedule of Meetings

The RSC shall meet upon due notice by its Chairperson as often as necessary to conduct the business of the RSC. As a minimum, the RSC will meet quarterly. The Secretary of the RSC or a member appointed by the Chairperson shall advise the members of the time and place of the meeting and shall arrange with the Chairperson for a different time of the meeting if the original time is not convenient for a quorum of the members. In the absence of a meeting call from the Chairperson and if pending business of the RSC needs to be resolved, a meeting can be called by any three of the regularly appointed members of the RSC.

Discussions, deliberations and actions taken by the RSC and the application review quorum will be recorded in the form of minutes and maintained on file for review. The minutes of each meeting will include the following: date of the meeting, members present and absent, and a summary of each issue acted upon. The minutes of each meeting will be provided to members of the committee. Each member is invited to review the minutes and to discuss any corrections to the minutes at the next meeting. Corrections adopted will be noted in the minutes of the meeting. Minutes of each meeting will be maintained on file by the RSO and circulated to personnel of UMKC having a specific interest in the proceedings or who request copies from the Chairperson.

All new requests and significant changes to existing authorizations, e.g., increase in personnel exposure, increase in limits on contamination, and/or release to unrestricted areas, shall be reviewed by the RSC prior to granting authorization.

### **1.2.6 Procedure for Conduct of Meetings**

The meetings of the RSC shall be conducted according to **Robert's Rules of Order** as they apply to such meetings, and the Chairperson shall use them as a guide at the request of any individual member. The following order of business shall be used as a guide in the conduct of RSC business:

- Approval of minutes of the previous meeting
- RSO report
- Announcements
- Old business
- New business.

Voting Procedure:

- Approval by a simple majority of a quorum is required for endorsement of motions made and seconded
- Mail ballots, including e-mail, may be used to resolve matters brought before the RSC when it is inconvenient to convene a meeting and the matters can be explained adequately by supplementary documentation. However, decisions made under this provision shall be reported and ratified at the next regular meeting of the RSC. A mail ballot does not constitute a meeting.

## **1.3 ALARA STATEMENT**

### **1.3.1 General**

As Low As Reasonably Achievable (ALARA) as originally conceived by the International Commission on Radiological Protection meant only that good practice should be applied to the solution of problems such that individual and group dose commitments would be reduced. As interpreted and codified by the NRC, ALARA has come to mean something else. Goals must be established, a program to reach these goals must be specified, and progress toward achievement of the goals must be recorded or the program is deemed to be deficient.

Senior management at UMKC is committed to maintaining its radiation safety program for the materials license consistent with the ALARA philosophy and for maintaining individual and collective doses ALARA. In accord with their commitment, an administrative organization for radiation safety will develop the necessary written policies, procedures and instructions to foster the ALARA concept within UMKC. All individuals who have safety responsibilities of any nature for the materials license, (e.g., administrative, operational, procedural and/or ancillary) will be instructed in the ALARA philosophy.

### **1.3.2 RSC ALARA Functions**

A formal, annual evaluation of the radiation safety program will be performed by the RSC including ALARA considerations. This will include reviews of operating procedures and exposure histories, laboratory inspections, etc., and meetings with DRS personnel.

The RSC will review each application with respect to the types of radionuclides and quantities requested and the

experimental protocols of use to ensure that appropriate measures will be taken to maintain exposures ALARA. The RSC delegates authority to the RSO for enforcement of the ALARA concept and will support the RSO when it is necessary for the RSO to assert authority. If the RSC overrules the RSO, it will record the basis for its action in the minutes of the quarterly meeting. The RSC and the RSO will encourage all authorized users to review extant experimental protocols and to develop new procedures as appropriate to implement the ALARA concept. The RSC will review each authorization at least every three years.

The RSC will review quarterly ALARA reports prepared by the RSO for the materials license. Appropriate action will be taken when external or internal radiation dose equivalents exceed the following calendar quarter investigational levels:

1. Total effective dose equivalent, i.e., the sum of the deep-dose equivalent (external exposures) and the committed effective dose equivalent (internal exposures), 125 mrem
2. Lens of the eye, 375 mrem
3. Shallow-dose equivalent to the skin or to each of the extremities, 1250 mrem
4. The sum of the deep-dose and the committed dose equivalents to any individual organ or tissue, 1250 mrem.

External radiation dose equivalent investigational levels, different than those above, may be established for an individual worker or group of workers involved with a materials license operation. Justification for the new levels will be documented and must be consistent with good ALARA practices. The RSC will review the justification for and must approve or disapprove all revisions of investigational levels pertaining to the materials license. Appropriate action will be taken when radiation/contamination guides are exceeded to ensure compliance with the ALARA concept.

#### **1.4 RADIATION SAFETY OFFICER**

The Chancellor has appointed and delegated to the RSO responsibility for and authority over the coordination and the implementation of the radiation safety program. The RSO coordinates the day-to-day control and management of radiation hazards arising from utilization of radiation sources within UMKC and ensures compliance with the conditions of the material license, the parts of the NRC's regulations applicable to radiation safety and any conditions imposed by the RSC. The RSO has the authority to inspect, audit, terminate or modify licensed operations at any time deemed appropriate by the RSO or by the RSC based upon their interpretations of the Federal regulations and/or conditions of the license issued to UMKC. The RSO develops and maintains basic procedures necessary to establish uniform practice throughout UMKC for the procurement, safe use and disposal of radioactive materials and other radiation sources. The RSO is empowered by the RSC to authorize changes of non-significant nature, e.g., minor increase in authorized quantities of radioactive materials, addition of small quantities of other radionuclides, room changes, etc. to an existing authorization.

The RSO or designee (hereinafter, RSO) serves to:

- Provide liaison in negotiations for licensing between the NRC and UMKC
- Implement the policies and procedures developed by the RSC
- The RSO will keep the RSC informed about the current status of each authorization including any special problems that may arise
- Coordinate the RSC's safety evaluations of all proposed user applications and uses of radioactive material to ensure compatibility with appropriate materials license conditions, rules and regulations
- Develop and maintain uniform methods, standards and procedures and the quality thereof for radiation safety coverage throughout UMKC
- Provide consultation and conduct training programs on all aspects of radiation safety to personnel at all levels of responsibility in accordance with the ALARA philosophy
- Write and publish general guidelines or procedures for radiation safety
- Perform quarterly audits of authorized user laboratories, facilities, experimental protocols and personnel training

- Receive, inspect and deliver all incoming shipments of radioactive materials and receive, package, label and ship all outgoing shipments of radioactive materials
- Maintain a quarterly inventory of all radioactive materials including those in storage and as waste
- Supervise and coordinate the radioactive waste disposal program including records pertaining thereto and maintain storage facilities
- Supervise the personnel monitoring program including determining the need for and evaluations of bioassays, maintain exposure records, notify personnel of exposures and provide recommendations for any remedial actions necessary to reduce personnel exposure
- Maintain all records pertaining to the radiation safety program
- Perform leak tests of all sealed sources
- Supervise decontamination and recovery operations in case of contaminating accidents.

#### **1.4.1 Special RSO ALARA Functions**

The RSO will prepare quarterly reports for the RSC. The reports shall include the following: external/internal radiation dose equivalents of authorized users and radiation workers, quarterly radiation/contamination surveys of authorized user facilities, and radioactive materials received and disposed of.

### **1.5 DIVISION OF RADIATION SAFETY**

Responsibility for execution of the radiation safety program is delegated by the Chancellor to the RSO and DRS personnel. The program must provide for the following:

- License conditions are to be satisfied by DRS
- DRS personnel will regularly inspect laboratory facilities of the authorized users by the methods and frequency developed by the RSO. A schedule for such review and reports of inspections shall be supplied to the RSC
- The RSO will receive, evaluate and prepare a report of the applications for use of radiation sources to be used by the RSC in their application review process. This report shall include a risk-level classification for the proposed use and assessment of the adequacy of radiation safety coverage.
- Procurement of radioactive material is to be controlled by **University Procedure 03.06**, which requires the assistance of the DRS to provide to the Procurement Department the names of the faculty authorized to purchase radioactive materials.
- The DRS will develop, operate, and maintain a suitable facility for the storage and processing of radioactive wastes preparatory to disposal of these wastes
- Releases of radioactive material to the environment are to be controlled by the DRS and by the authorized user to maintain releases within ALARA
- Special procedures are to be developed in collaboration with the RSO.

#### **1.5.1 Special DRS ALARA Functions**

Liquid radioactive materials released to the environment will be done by DRS personnel only in accordance with the regulatory release limits per radionuclide and the ALARA concept. Airborne releases of radioactive materials will not be done as part of any experimental protocol unless containment of the radioactive materials cannot be maintained. Then and only then will releases be permitted to the environment and they will be controlled by DRS personnel in accordance with regulatory release limits and the ALARA concept.

### **1.6 AUTHORIZED USER**

### 1.6.1 Description

All operations in which there is the possibility of exposure of faculty, staff or students to ionizing radiation shall be supervised by technical personnel who are competently aware of the radiation hazards and of the means to minimize them. Such person will usually be those who have been authorized by the RSC to use the radioactive material or radiation source. The supervisor shall function as laboratory safety officer by ensuring compliance with these rules and regulations as well as making certain that these rules have been posted and brought to the attention of all associates.

### 1.6.2 Responsibilities

Training responsibilities will be shared by the RSO, the authorized users and supervisory personnel. The RSO will provide training in regulatory and license requirements, in radiation safety fundamentals and practices specific to UMKC authorized users, radiation workers and ancillary personnel. The authorized users and supervisory personnel will provide training for the radiation workers and others under their supervision in specific safe use of radioactive materials or radiation sources for their experimental protocols.

The authorization to use radioactive materials or radiation sources under UMKC's byproduct material license conveys with it a specific place of use. The user shall not vacate this place of use without clearance from the RSO attesting a release to unrestricted use; and the user shall not move to a new location without the approval of the RSO or the RSC.

An Authorized User must keep a record of the receipt, use, storage and disposal of radioactive materials so that he can, at any time, calculate the quantity on hand in the laboratory, including waste.

The Authorized User is responsible for the security of the radioactive material in the laboratory. See **Section 7.0**.

Authorized Users will be required to perform documented radiation/contamination surveys after each day of use of uncontained radioactive materials in a laboratory to demonstrate that control of licensed material has been maintained. Daily surveys are not required in laboratories in which sealed sources are used.

Collection and storage of wastes within the laboratory are the responsibility of the laboratory supervisor. He will ensure compliance with applicable regulations and maintain control of radioactive wastes until such accumulated wastes are removed by the RSO. He will also segregate and properly label all radioactive and mixed waste materials. See **Section 4.0**.

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#### Notes

1. Legal name of the corporation.

## 2.0 RADIATION CONTROL

## 2.1 GENERAL

UMKC has a diversified program of research and teaching utilizing radioactive materials and other radiation sources. This diversification complicates the operations necessary to achieve adequate control of the hazards arising from these uses. It is not that a single laboratory constitutes a serious control problem, but that dozens of such laboratories, each using different materials and different experimental techniques, become collectively a more serious problem. These instructions are intended to aid the authorized user and associates (hereinafter user) in the performance of an experimental program without compromising their safety. A separate supportive staff of radiation safety personnel will assist the user in maintaining a safe condition. Primary responsibility remains with the user, however.

This Section contains recommendations which are intended to minimize the exposure of faculty and staff to radiation or radioactive contamination within UMKC and to protect the welfare of the community-at-large. Federal and State regulations governing the use of radiation sources are intended to accomplish the same objectives; consequently, as long as the recommendations in this Section are followed, UMKC will remain in compliance with the Federal and State regulations. Since recommendations made to cover a general situation cannot be made always to cover each special situation, there will be many instances in which these recommendations do not apply or in which a satisfactory interpretation cannot be made. In such situations, the RSO should be contacted for assistance; and if the question cannot be resolved, it will be presented to the RSC for resolution. Interrelationships of the RSC and the RSO are described in **Section 1.0**.

Recommended methods for protection from radiation and for control of contamination by radioactive materials are outlined in **NCRP Report No. 30** (1). Methods recommended for radiation protection from x-ray machines are outlined in **NCRP Reports No. 35, No. 49 and No. 102** (2). Hazards to personnel involved in the handling of radiation sources arise from the following kinds of exposure:

- Internal exposure resulting from deposition of radioactive materials within the body by way of ingestion, inhalation, entrance through breaks in the skin, or penetration through the skin barrier.
- External exposure of the whole body, or parts of the body, arising from penetrating radiations, such as x and gamma rays, high energy beta particles, or neutrons.

Hazards to personnel using x-ray equipment can be minimized or even eliminated effectively by use of properly designed radiation shields, safety interlocks, and careful techniques. With intensities many orders of magnitude greater than from most gamma-emitting sources, the potential of an injury-producing exposure from an x-ray machine is far greater. On a relative basis, therefore, very careful use of x-ray equipment is indicated. There is the advantage, however, that an x-ray machine can be turned off when not in use.

The relative hazards of the different radioactive materials in common use, expressed in terms of the quantity of each that presents a low, medium, high, or very high hazard are illustrated on page 12 of **NCRP Report No. 30, "Classification of Degree of Hazard."** This chart is available in the DRS for the review and guidance of users of radioactive materials within UMKC. Users should familiarize themselves with the relative position of each material to safeguard themselves and their associates.

The chart does not provide for adjustment of the relative hazard due to the form of the material nor for the type of operation being performed. Values given on the chart may be modified according to the following scale:

Operational Factors

Type of Operation	Multiply mCi values by
Storage	100
Very Simple Wet Operations	10
Normal Chemical Operations	1
Complex wet operations with risk of spills	0.1
Simple dry operations	0.1
Dry and dusty operations and those where isotopes are evolved as gases	0.01

These values apply essentially only to open bench operations for chemical or physical forms that are not modified in form by contact with air. For example, tritium in the form of water vapor is more hazardous than tritium released as a gas. Also, these values do not account for the reduction in a hazard afforded by containment resulting from use of fume hoods or glove boxes.

Some studies have indicated an increased toxicity of about a factor of ten for tritium when it is bound in an organic form that remains stable within the body and is not eliminated by metabolic processes. Of special importance are the DNA and RNA precursors like thymidine. When in this form, tritium shall be considered in Group 3, Medium Hazard when evaluating its relative hazard. On the other hand, a chemical form that increases the stability of the compound will decrease the risk of inhalation and transport by absorption through the skin, which reduces somewhat the problem of containment.

A listing of the publications which have served as a basis for the recommendations to follow and which may be of additional assistance to the users of radiation sources within UMKC is maintained in DRS.

## 2.2 PERSONNEL RADIATION CONTROL

Persons working with or handling radiation sources may control external exposure to themselves by utilizing time, distance, and shielding. The exposure from a point source emitting gamma radiation varies: a) directly with the time of exposure, b) inversely with the square of the distance to the source, and c) inversely with the absorption of radiation by the shielding material. It is a generally accepted concept of radiation safety practice that work with radioactive materials requires the experimenter to be as far from the source as possible to accomplish the operation without strain and in a minimum time. At this distance, the necessary further reduction in exposure is accomplished by adding shielding between the source and the experimenter.

The radiation safety program is dedicated to the principle of maintaining individual exposures at levels ALARA. This must be a cooperative effort in which each individual exercises responsible judgment in the use of this potentially hazardous material. It is the function of the DRS staff to assist the user to accomplish the goal of minimizing exposures.

### 2.2.1 Training For Individuals Working In Or Frequenting Restricted Areas

Minimum acceptable training and experience criteria shall be formulated by the RSO and approved by the RSC in accordance with NRC Regulatory Guides and licensing practices for materials licensees. Various training criteria will be established for radiation workers and for ancillary personnel. Prior training and experience will be verified during the safety evaluation of new applications to use radionuclides. Training will be provided by the RSO, the authorized users and supervisory personnel. Training must be completed prior to work assignments in a restricted area. Refresher training sessions will also be conducted. Worker understanding of training topics must be demonstrated to the satisfaction of the RSO before the worker will be allowed to work in a restricted area.

The RSC has authorized a wide range of radiation use programs that require several different sets of training and experience criteria. Options for development of minimal criteria for some low level uses and more restrictive criteria for high level uses will be formulated. A tiered system of minimum training and experience criteria for various individuals working together in a research laboratory would allow for flexibility in the types of work that could be performed. There are three distinct levels of radiation workers: 1) Authorized users and supervisory research personnel, 2) Supervised research technicians and radiation worker trainees and 3) Ancillary personnel. Ancillary personnel will include the staffs of the Custodial, the Campus Facilities Management and the Police Departments. Progressive training and levels of experience will allow workers to increase their ability to work unsupervised without compromising safety.

Training criteria for specific quantities and uses:

1. Individuals that use unsealed sources in amounts less than ten times **Schedule B, 10 CFR 30.71** or that use only in vitro clinical testing kits may complete reduced training and experience requirements.
2. Individuals that use sealed sources and foils that are housed in a specific device may require instruction in operating procedures for that device. The training and experience criteria should meet the device manufacturer specifications for user training.
3. Individuals that use gas chromatograph detector cells, and who will not dismantle the detector cells may complete a brief orientation and no further training or experience may be required. Individuals that use alpha, beta or gamma check sources for instrument calibration and standardization that are less than the removable activity limit for leak testing sealed sources may complete a brief orientation and no further training or experience may be required.

In all cases, demonstrated competence of the worker will be verified, confirmed and documented prior to issuing an authorization to use radioactive materials and prior to working unsupervised with radiation. All first time uses of radioactive materials by any individual will be supervised by the RSO.

Training responsibilities will be shared by the RSO, the authorized users and supervisory personnel. The RSO will provide training in regulatory and license requirements, in radiation safety fundamentals and practices specific to UMKC authorized users, radiation workers and ancillary personnel. The authorized users and supervisory personnel will provide training for the radiation workers under their supervision in specific safe use of radioactive materials for their experimental protocols.

Topics covered in training sessions will include all applicable NRC regulations and license conditions, **10 CFR 19 and 20, NRC Regulatory Guides 8.13 and 8.29, NRC Form-3, ALARA**, the UMKC Handbook of Radiological Operations and specific do's and do not's as they apply to the radiation safety program at UMKC. Topics will also include a description of the areas in the buildings where radioactive materials are used and the potential hazards associated with that use, the personnel monitoring program, occupational dose limits, radiation safety fundamentals and emergency procedures. Records of training will be retained by the RSO and will include the following: course outlines and materials used, dates of training, names of attendees and instructor. The training will be provided by the RSO, the authorized users and supervisory personnel who, by their training and experience, are authorized by the RSO to provide training to their associates. Refresher training will be provided at least annually or as necessary to keep personnel in each worker category up to date with changes in the NRC regulations and/or UKMC procedures.

### **2.2.2 Personnel Monitoring**

In accordance with the requirements of **10 CFR 20**, all persons who receive or are likely to receive a dose of radiation shall wear a personnel monitoring device. These devices will be changed at regular time intervals and processed by a dosimetry processor who meets the requirements of **10 CFR 20**. A record of the dose equivalent received during the interval, for the calendar quarter and an annual total accumulation will be maintained by the RSO. Requests for monitoring service should be addressed to the DRS with the name of the individual who will wear the dosimeter, Social Security number, birth date and sex. A special form is available from the DRS to facilitate the recording of these data.

The external exposure monitoring program will be applied to the following categories of personnel at UMKC:

1. Those individuals who are occupationally exposed to radiation sources will be assigned appropriate dosimeters.
2. Those individuals who, on a regular basis, handle radiation sources will be assigned appropriate dosimeters.
3. Those individuals who are exposed to radiation sources on an occasional basis will be assigned appropriate dosimeters at the professional discretion of the RSO.

The RSO will promptly review all personnel exposure reports to look for any individual whose exposures are out of the ordinary and immediately investigate them.

UMKC presently uses personnel monitors of three distinct varieties. They are as follows:

1. A lapel dosimeter sensitive to beta, gamma and x radiations. This dosimeter will be assigned to individuals exposed to whole body high energy beta, gamma or x radiations.
2. A ring dosimeter sensitive to high energy beta, gamma and x radiations. This dosimeter will be assigned to



individuals exposed to extremity high energy beta, gamma or x radiations.

3. Small direct reading ionization chamber sensitive to gamma or x radiations. This dosimeter will be assigned to individuals exposed to gamma or x radiations.

Of these three dosimeters, the first listed is the most common and also the least costly. The second type is used to evaluate exposure to the extremities. The third is used to provide a measure of a short-term exposure when processing and reporting of the commonly used dosimeters will delay taking effective remedial steps to reduce external exposure. This situation amounts to providing a means of monitoring hourly or daily exposures to supplement the reading of the lapel or ring dosimeter. Other uses are to monitor brief exposures resulting from special operations or to monitor transient visitors.

With the single, personnel monitoring device, we hope to measure something approximately the same as the exposure to the whole body. The whole body, as the critical organ, is defined to include the blood-forming cells and the gonads. Obviously, a single detector can only suggest the magnitude of the whole-body exposure. After extended use, the plastic film holder may become worn or damaged. Such holders should be replaced promptly with a new holder obtained from the RSO. Occasionally, a badge holder will become contaminated with minute quantities of radioactive material. When this occurs, the report of exposure to radiation will reflect an unexpected increase, and the suspected presence of contamination will be reported by the supplier. These badge holders shall be taken from service and replaced by the RSO.

Criteria for assigning each variety of dosimeter will be in accordance with the requirements of **10 CFR 20**, the personnel categories above and the professional discretion of the RSO. In general, occupationally exposed workers in laboratories could be assigned dosimeters of variety 1, 2 or 3. Personnel who are occupationally exposed on an occasional basis in a laboratory could be assigned dosimeters from any of the three varieties. Dosimeters will not be assigned to personnel working with radiations below the energy response or sensitivity of the dosimeter. For example, personnel who use only H-3, would not be issued a dosimeter but it may be necessary to conduct bioassays. Dosimeters will not be assigned when it can be demonstrated by calculation and documented that the dose will not exceed the limit specified in **10 CFR 20**. Dosimeters may be withdrawn from use if documentation or circumstance over a period of three to six months indicates minimal radiation dose and area radiation and contamination surveys are background levels and the experimental protocol will not change. Appropriate dosimeters will be assigned to any individual less than 18 years of age as per **10 CFR 20**. Personnel will receive training in the proper use and care of dosimeters assigned to them.

### 2.2.3 Declaration of Pregnancy Policy

The RSC has approved the following policy with regard to pregnancy of authorized users and radiation workers:

1. Authorized users and radiation workers will be informed of this policy at site-specific orientation lectures and at retraining sessions.
2. Pregnant radiation workers have the option of declaring their pregnancy. To do so, the radiation worker must contact DRS and fill out a Declaration of Pregnancy Form.
3. Upon completion of the form, a review of the past exposure history and current working procedures will be conducted with the radiation worker by the Health Physicist, the Asst. Health Physicist or the RSO.
4. A decision made in which modifications of work procedures or assignments, is required, on the basis of health and safety concerns, will be reviewed by the RSO.
5. If it is determined that the radiation worker can continue to work safely without exceeding the limits for fetal exposure limits in **10 CFR 20** and **NRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure,"** the laboratory supervisor may require the radiation worker to continue to work with radioactive materials.
6. At any time during the pregnancy, the radiation worker has the option of undeclaring the pregnancy and then the exposure limits become the same as for any radiation worker.

### 2.2.4 Medical Examinations and Bioassays

When deemed necessary by the RSC and as required by Federal or State regulations, a medical examination or special bioassay procedure may be ordered for individuals who will be working with materials or equipment producing ionizing radiation. The RSC will identify the workers who are to receive subsequent physical examinations. Records maintained

of radiation dose equivalent will assist the RSC in its evaluation of examination needs. Any question of the need for a special physical examination should be brought to the attention of the RSO. He will assess the potential hazard of the radiation environment, so that this assessment can be presented to the RSC at the same time as the report of the clinical problem. The RSC can then evaluate the clinical problem in terms of the radiation environment to be experienced.

Bioassay procedures are performed for personnel when they have been exposed to significant quantities of uncontained (1) radioactive materials. The type of bioassay performed is determined by the radionuclide, the critical organ involved and the biological metabolism and turnover of the radionuclide in the body.

In general, bioassays are performed for tritium and most beta emitters by liquid scintillation analyses of urine specimens. Gamma emitter bioassay methods are by external measurement techniques. In some instances, urinalyses can be used to support, confirm or deny the external measurement results. The preferred bioassay method(s) will be determined by the RSO in accordance with published analytical procedures. Normally bioassay procedures are performed after a delay of at least six hours after exposure, unless there is reason to expect a significant uptake. The bioassay trigger levels, the frequency and the action level for follow-up procedures, if required, are based upon **NRC Regulatory Guides 8.20 and 8.32**.

When tritium is used in uncontained form, a bioassay of a urine specimen is required for each person involved in the handling of the material under the following conditions:

1. For tritium in uncontained form, of quantities greater than 10 millicuries, processed in an open room, a bioassay shall be performed within one week of single contact or weekly for continuous contact (2).
2. For tritium in uncontained form, of quantities greater than 100 millicuries, processed in an approved, functioning fume hood, a bioassay shall be performed within one week for a single contact or weekly for continuous contact.
3. For tritium when there may have been absorption, ingestion or other accidental deposition in the body of a quantity greater than 250 microcuries, a bioassay shall be performed immediately in order that medical intervention might be considered if a significant uptake has occurred.

Action levels have been established and are posted in the DRS.

When Iodine is used in uncontained form, a bioassay will be performed using a gamma sensitive detector placed close to the thyroid gland. The bioassay will be performed six hours or more after the contact, but within ten days of the contact, for each person involved in the handling of the material under the following conditions:

1. For Iodine (I-125 or -131) in uncontained form, of quantities greater than one millicurie processed in an open room, a bioassay shall be performed after six hours of contact but within ten days for a single contact and weekly for continuous contact.
2. For Iodine (I-125 or -131) in uncontained form, of quantities greater than ten millicuries processed in an approved, functioning fume hood, a bioassay shall be performed after six hours of contact but within ten days for a single contact and weekly for continuous contact.
3. For Iodine (I-125 or -131) when there may have been absorption, ingestion or other accidental deposition in the body of a quantity greater than 0.1 microcurie, a bioassay shall be performed immediately in order that medical intervention might be considered if a significant uptake has occurred.

Action levels have been established and are on file in the DRS.

Each investigator for whom these bioassay requirements apply is urged to reduce his individual contacts with uncontained tritium and iodine-125 or -131 to minimize the number of bioassay procedures to be performed. For example, an investigator who keeps a supply of more than one curie of tritium as HTO but uses only 50 or so millicuries for each experiment can at one time divide the more than one curie into aliquots of less than one curie each requiring but one bioassay. More than avoiding bioassays, this practice will also reduce the risk of hazardous exposure, and it is recommended on that basis.

Additional bioassays may be required by the RSO when large quantities of other radioactive materials are handled in an uncontained form.

### **2.2.5 Some Rules for Laboratory Practice**

The control of an internal exposure caused by the entry of radioactive material into the body requires the provision for the proper use of equipment, good housekeeping, and good personal habits. Typical guides for experimenters using these materials are the following:

- Materials authorized for use **shall** (3) always be under the secure control of the authorized user
- Smoking, eating, or drinking **shall** not be permitted in laboratories posted with “Caution – Radioactive Material signage
- Food containers **shall** not be permitted in the laboratory and refrigerators **shall** not be used for common storage of food and radioactive material
- Items necessary to the safe conduct of the experiment **should** (3) be checked to ensure their availability and operational status before the experiment is started
- The laboratory **should** be kept neat and clean. Equipment or material not being used should be stored in a place away from the work area
- Work **should** be planned ahead, and whenever possible a simulated or dry run **should** be accomplished to test the procedure
- Items of equipment intended to provide features of safety **shall** be evaluated periodically to ensure that they are providing the safety feature intended. For example, a fume hood in which radioactive materials are handled **shall** provide a uniform air flow through the openings of the hood of at least 100 linear feet per minute with the sash one-half open
- Transfers and dilutions **shall** be performed in operating fume hoods or glove boxes, unless it is completely safe to do otherwise
- Pipetting **shall** not be done by mouth. Rubber bulbs, syringes, or other mechanical devices **shall** be used
- Radioactive material in liquid form **should** be stored and transported in double containers (4). Place all containers on a lipped tray
- Fingernails **should** be kept short and clean
- If there is a break in the skin below the wrist, gloves or a covering over the break **should** be worn
- Flammable liquids such as ether, benzene, or acetone **shall** not be permitted in a laboratory where radioactive materials are used or stored unless they are contained in U.L. approved safety cans with antiflashback screens and are used in a properly vented enclosure
- Pressure bottles or tanks containing counting or laboratory gases **shall** not be used or stored in the laboratory where radioactive materials are used or stored unless they are securely mounted to the wall, a bench, the floor or other rigid system to prevent them from becoming hazardous missiles.

### 2.2.6 Protective Apparel

Protective apparel includes laboratory coats, coveralls, gloves, shoe covers, safety glasses, and respirators. In most cases, however, the laboratory coat and gloves will provide adequate protection. Laboratory coats intended for use while working with radioactive materials are to be used under the following conditions:

- Protective apparel **should** be buttoned up when worn

- Protective apparel **should** not be worn out of the laboratory area
- Protective apparel **shall** not be stored with street clothes
- Protective apparel **shall** be monitored periodically and always prior to being laundered (5).

Open-toed shoes or sandals **should** not be worn in the laboratory while working with radioactive materials because of possible skin contamination.

### 2.3 AREA RADIATION CONTROL

Adequate area radiation protection and control of contamination are dependent on proper laboratory design, including the location of fume hoods or glove boxes, and layout of work and counting areas; the use of appropriate construction materials; and on the establishment of safe, workable, laboratory routines. Most applications involving radioactive material conducted within UMKC may be accomplished with very ordinary equipment. If in doubt about the use of specific items of equipment, please enquire of the RSO.

The authorization to use materials under UMKC's materials license conveys with it a specific place of use. The user shall not vacate this place of use without clearance from the RSO attesting a release to unrestricted use; and the user shall not move to a new location without the approval of the RSO or the RSC.

The Authorized User is responsible for the security of the radioactive material and the laboratory. See **Section 7.0**.

#### 2.3.1 Equipment

Surface materials used in construction of laboratories should be of an impervious type. Laboratories that have been converted for the use of radioactive materials may be used subject to approval by the RSC of the description of the laboratory contained in the application (See **Section 5.0**). Materials are available that may be used to seal existing pervious surfaces.

Where contamination is expected, the surfaces should be protected with a disposable covering. Limited quantities of disposable covering material are available from the DRS; where more than a small quantity is needed, such supplies must be obtained by the using laboratory through regular purchasing procedures.

Laboratory operations involving more than low-level activity shall be conducted within fume hoods that are designed properly and are operating. Any fume hood not providing a minimum air flow of 100 linear feet per minute measured with the sash one-half open is not adequate for work with radioactive materials and shall not be used unless the fume hood has been approved for limited use by the RSO. Glassware, pipettes, gloves, and other laboratory apparatus when once used with radioactive materials, shall be reserved for such use and shall not be mixed with "clean" equipment. It is preferable that they are stored in a separate cabinet that is so labeled. They shall not be returned to stock.

Operations with heavy radionuclides such as Po-210, which emit alpha particles and which may be used in such a form as to create an internal hazard by ingestion or inhalation, shall not be conducted except in a glove box. This restriction is imposed to limit the risk of permanent impairment of health to personnel who may not be aware of the extreme toxicity of these alpha emitters. A fume hood, whatever the air flow, does not provide an adequate control of the environment to prevent a hazardous exposure.

Fume hoods, glove boxes, or other enclosures intended to control or contain particulate or gaseous forms of radioactive material need not be filtered unless the quantity in use is large enough so that Maximum Permissible Concentrations are exceeded at the discharge point. If particulate matter is present in sufficient quantities to exceed MPC values, a suitable filter placed in an accessible portion of the exhaust duct is indicated. It must be accessible so that it can be replaced when necessary. Since a particulate filter is ineffective for a gaseous effluent, other arrangements, to reduce the concentration at the exhaust point, must be made when high concentrations in the gaseous form are expected. A charcoal filter is effective for some gases.

Some transuranic elements available for research are spontaneously fissionable or emit neutrons spontaneously. This behavior places them in a higher category of hazard than the alpha emitters. For this reason, the RSC will be especially sensitive to the detailed description of handling procedures contained in the application. Of course, for the applications of use of these materials in which the source is sealed within a leakproof capsule, they are no more hazardous than other sealed sources emitting similar types and quantities of radiation. But when the material is to be used in an uncontained form, all operations must be contained within a functioning glove box and proper instrumentation must be available to

warn the investigator of any breakdown of the containment.

### 2.3.2 Area Monitoring

DRS personnel will survey and inspect quarterly all laboratory's using uncontained radioactive materials to demonstrate that control of licensed material has been maintained. Additional surveys will be performed as required by regulations and safety requirements. The surveys will include area radiation levels and removal contamination measurements in the restricted and surrounding areas. Air sampling will be performed if air concentrations are suspected of being in excess of the applicable **10 CFR 20** limits.

Authorized users will be required to perform documented surveys after each day of use of uncontained radioactive materials in a laboratory to demonstrate that control of licensed material has been maintained. Daily surveys are not required in laboratories in which sealed sources are used in gas chromatographs, gamma or liquid scintillation counters.

Surveys of the work area should be performed at the completion of a radioactive material use session, e.g., experimental run, work period or end of the day. The surveys shall include wipes of surfaces to evaluate removable contamination levels. Area exposure rate measurements must be obtained when gamma or medium to high-energy beta emitters are in use. Surveys must be documented by a written, signed and dated entry in a log book. Usually ten to fifteen survey locations are sufficient to document a survey of a radioactive materials use area. Areas in which radioactive materials are not used should also be surveyed, e.g., the floor outside the laboratory, door handles, a telephone, etc. The counting system used for wipe analyses must have an efficiency posted for the radionuclide(s) in use. Results of wipe analyses must be reported in dpm. Survey meters must be operational and should have been calibrated within the past year.

Individuals using millicurie quantities of P-32 must use a low density shielding barrier, e.g., Plexiglas, in order to minimize the bremsstrahlung radiation. A mandatory radiation and contamination survey must be performed after each use of P-32 involving more than one millicurie and ring badge dosimeters must be used for these procedures. A dry run of procedures utilizing P-32 shall be conducted in the presence of the RSO prior to the initial use. The RSO will supervise all new RSC approved procedures involving the use of any radioactive materials.

Each laboratory shall have a survey meter or laboratory monitor readily available to it that is capable of detecting radiations from the material in use. Laboratories using small quantities of weak beta emitters such as H-3, C-14 or S-35 exclusively are exempted from this requirement. This instrument shall be used to monitor all operations involving radioactive materials. All equipment used in the operation and all areas subject to contamination should be monitored after each day's use, and an appropriate entry should be made in the user's log book to document the results of the survey.

Laboratories using small quantities of weak beta emitters such as H-3, C-14 and S-35 shall take filter paper wipe samples of all equipment and all areas subject to contamination, analyze these wipes in a liquid scintillation counter and record the results in dpm in the user's log book to document the results of the survey. These surveys are the responsibility of the authorized user, and any uncertainty about what is required should be resolved by consultation with the RSO. The RSO may be contacted to provide assistance in establishing the proper method of survey and procedure for recording the results. Contaminated equipment or surface contamination shall be so labeled until decontaminated. See **Section 2.0** for an identification of the proper kind of label to use. See **Section 4.0** for a description of the procedure for disposal of contaminated equipment. All plumbing and air-exhaust ducts in laboratories using radioactive materials shall be monitored before undertaking repair. Sink traps, piping, and ducts that are likely to be contaminated shall be labeled.

Radiation exposure rate guides are posted in the DRS.

### 2.3.3 Contamination Levels and Decontamination

In any laboratory where radioactive materials are used in an active research program, it is inevitable that minor spills or other conditions of contamination will occur despite the best efforts of the user to prevent them. The prompt attention of the user to the decontamination of these minor spills will minimize the hazard and result in the maintenance of a "clean" laboratory. At times, even these minor spills will resist all normal efforts for decontamination. If such a result is experienced, the RSO shall be contacted for assistance. Special complexing agents are available to aid in removing the persistent attachment of some chemicals to the surface.

Occasionally, a more serious contamination problem will result from an accident or from an unexpected development of the experiment being performed. In this situation, the person conducting the experiment shall immediately institute the emergency procedure outlined in **Section 2.0** as adapted to the circumstances of the problem. It will be necessary in every such instance to notify the RSO to provide an evaluation of the degree of hazard involved.

UMKC is obliged to report to the Office of Nuclear Materials Safety and Safeguards any incident of contamination or

radiation exposure that exceeds certain minimum levels as described in the Federal regulations. The RSO will determine whether or not the specific circumstance of contamination or exposure exceeds the limits set by these regulations.

Contamination guides are posted in the DRS.

### 2.3.4 Special Problems Related to Use in Animals

Use of radioactive material in animals is a rather special case of area radiation control. For smaller animals kept in cages or pens, the contaminated areas are restricted and can be kept clean. Or, at least, these small areas are easier to decontaminate. But for larger animals, even though they may be penned, the area involved is so much larger that decontamination becomes more difficult. It is for this condition that careful preplanning is recommended. This preplanning of the experiment involving animals of larger size should make proper allowances for physiological elimination of the radioactive material by the animal. Prediction of elimination rates and modes of elimination in advance of administration of the radioactive material will permit a more timely identification of the level of contamination to be expected. Obviously, if the radioactive material stays with the animal, no contamination problem can result. But if the total quantity administered is excreted in a few days or less, a substantial fraction of the amount administered will be a source of contamination that must be controlled. Disposal of contaminated animal wastes is discussed in **Section 4.0**.

## 2.4 EMERGENCY PROCEDURES

### 2.4.1 Definition

The term "emergency" is taken to mean any incident resulting from the use of radioactive materials that presents an internal or external hazard to personnel. Such an incident may vary in magnitude from a simple spill of low-level activity in a laboratory that is relatively easy to clean to a fire or explosion that disperses quantities of radioactive material over a wide area. The materials involved could be solids, liquids or gases. For incidents occurring during the work day, call the Police Department at (816) 235-1515 or 911 from a campus telephone; the HP at (816) 235-5289, pager number (816) 435-9834 using the procedure below; the Asst. HP at (816) 235-1844, pager number (816) 435-9831; or the RSO at (816) 235-1819, pager number (816) 435-9830. For incidents occurring during off-hours, call the UMKC Police Department at (816) 235-1515 or 911 from a campus telephone. They in turn will contact DRS personnel.

■ Pager procedure for touch-tone phones only: Dial pager number. You will hear a **RING** and a **BEEP**. Dial the number you wish called, then hang up.

### 2.4.2 Procedure

The general procedure to follow in an emergency is:

■ For minor or major spills of radioactive materials, if fire is involved, call the Police Department immediately: Call (816) 235-1515 or 911 from a campus telephone. They will contact the Kansas City Fire Department and other necessary emergency services.

For **minor** spills of radioactive liquid:

- Use absorbent material to limit the spread
- If contamination is airborne, close windows, doors, vents and turn off ventilation
- Minimize radiation exposure to personnel by evacuating them from the area involved to an isolated area, but keep them there until they can be checked for contamination
- Notify the laboratory supervisor
- Notify the HP, the Asst. HP or the RSO
- Post warning signs and allow no one to enter the contaminated area unaware; carefully clean up the area; insert all cleanup materials into a plastic bag and dispose of it in the radioactive waste container
- Survey the area around the spill, your hands and clothing for contamination.

For **major** spills of radioactive liquid:

- Evacuate the laboratory. Notify all persons not involved in the spill to vacate the area
- Use absorbent material to limit the spread
- If contamination is airborne, close windows, doors, vents and turn off ventilation
- Vacate and lock the laboratory to prevent entry
- Post warning signs and allow no one to enter the contaminated area unaware
- Notify the laboratory supervisor
- Notify the HP, the Asst. HP or the RSO
- Minimize radiation exposure to personnel by evacuating them from the area involved to an isolated area, but keep them there until they can be checked for contamination
- If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure
- Clean up the spill with supervision by the RSO.

After any emergency is over and all hazards are under control, prepare the University Fire Report and Accident Forms if appropriate. These emergency procedures shall be extracted from the text, modified by the addition of appropriate names and telephone numbers, expanded with special instructions and posted in each laboratory authorized to use radioactive materials. Please check the telephone numbers given; they are subject to change.

### **2.4.3 Access and Security Control**

Personnel of the UMKC Police Department have the authority to, the capability to, and will provide facility and area access control and security in the event of a radiological emergency. They also have an internal personnel call up schedule for all types of emergencies including radioactive material/radiation, and an external notification system linked to the Kansas City Police and Fire Departments. They can also summon medical emergency assistance as required. For minor medical emergencies, patients are transported to St. Luke's Hospital of Kansas City, 4401 Wornall. For major life threatening medical emergencies, patients are transported to the nearest medical facility.

Off-site radiological assistance is available from UMC Health Physics Services, Columbia, MO., telephone number (573) 882-7221.

### **2.4.4 Personnel Decontamination**

When an individual is injured as a result of a laboratory accident, the first consideration should be to seek medical attention for the victim. If, however, the individual has been contaminated with radioactive material as a result of the accident, the following steps may be taken while awaiting the arrival of a physician to administer to the needs of the injured victim:

- Persons splashed with radioactive solutions should wash or be washed immediately with ample quantities of water. A mild, pure soap may be used
- If radioactive material has been swallowed but after transferring the person to a suitable clinical facility, a stomach pump may be used by the clinical staff to remove the ingested material
- The attending physician should be informed upon his arrival of the likelihood of ingestion or inhalation of radioactive materials as they are extremely dangerous when taken internally. The physician should also be advised if the patient represents a significant radiation source.

### **2.4.5 Area Decontamination**

Decontamination shall be accomplished by laboratory personnel under the supervision of the RSO. This means that the labor required affecting the decontamination and the expense of special materials and services needed to implement the decontamination are to be provided by the using laboratory.

## **2.5 OTHER RADIATION SOURCES**

As defined by the RSC, radiation source means any material or device from which ionizing radiation is emitted spontaneously or from which such ionizing radiation can be produced. In this broad sense, a source of radiation may be an x-ray generator, an electron microscope, a naturally occurring radioactive material, a reactor, an accelerator, or a byproduct material. Most specific instructions given in the Handbook relate to radioactive materials, both naturally occurring and artificially produced. However, this emphasis on radioactive materials is not intended to exclude the equally important need for control of radiation hazards engendered by operation of machines which produce ionizing radiations.

All sources of radiation that are not covered specifically by the Code of Federal Regulations are covered by the State of Missouri's Radiation Protection Regulations. Federal control is exercised over reactors, byproduct materials, source materials, and special nuclear materials as defined by the Federal regulations. X-ray generators, accelerators, and naturally occurring radioactive materials are controlled by the State. Within UMKC, no distinction is made to the origin of the controlling regulation, either State or Federal, since the same standards of radiation safety have been applied to both. UMKC can, therefore, establish, by means of the Handbook, a uniform code or set of regulations that satisfies either the State or Federal regulations.

The basic criterion to be applied to the radiation safety aspect of installation and use of radiation sources is identical to that applied to use of byproduct materials. Such sources are to be installed and used in a way that will not endanger life or property. This criterion is satisfied if the installation of the radiation source is made with provision for adequate safeguards such as radiation shielding, remote operation, restricted accessibility, and so forth. All radiation sources within UMKC will be inspected to determine that this basic criterion is satisfied effectively, after which an appropriate certificate attesting this fact will be issued to the person responsible for the use of the source. Any new installations of radiation sources must be reviewed with the RSO to ensure compliance with pertinent regulations.

## **2.6 RECEIPT, STORAGE, AND USE OF RADIOACTIVE MATERIAL**

### **2.6.1 General**

Details of the State and Federal regulations pertaining to receipt, storage, and use of radioactive materials are available for review in the DRS. These requirements are consolidated and summarized here for the convenience of the user of such materials. If the statements to follow are not sufficiently clear or adequately detailed to provide guidance and if the actual regulation does not indicate what to do, the user should consult with the RSO to establish a proper interpretation of the regulation.

### **2.6.2 Procedures for Opening Packages Containing Radioactive Material**

The Federal regulations require among other things that "Each licensee shall establish and maintain procedures for safely opening packages in which licensed material is received, and shall assure that such procedures are followed and that due consideration is given to special instructions for the type of package being opened." Besides the quoted passage, compliance with the remainder of this section of the regulation has necessitated a change in the methods employed by UMKC to obtain radioactive materials. Administrative controls on the purchasing and delivery mechanisms for radioactive material are imposed by the NRC. When these administrative controls are all functioning, the RSO will be responsible for approving the purchase, and for receiving, inspecting, and monitoring RAM packages for subsequent delivery to the user. The RSO will telephone the user prior to delivery of the package to ensure that someone authorized to use radioactive materials will be in the laboratory to receive and to sign for the receipt of the package. If no one is available in the laboratory to accept the package, it will be retained in the custody of the RSO until such time that it can be delivered to an approved individual. If an individual user receives a package misdirected to him, he should not attempt to open the package but should telephone the RSO immediately. DRS personnel will monitor and open the package.

The following procedures are to be used to open packages of radioactive materials. DRS staff will:

1. With protective covers on the hands, inspect the package for integrity and evidence of leakage.
2. Monitor external surfaces for contamination and exposure rates. The limits for contamination and exposure rates are



those given in **10 CFR 20** and **49 CFR 172**.

3. Check labels and shipping papers to ensure the shipment is to the correct address and contains the ordered radionuclide and activity.
4. Open the outer container and inspect the inner container for integrity and evidence of leakage.
5. Monitor packing material and inner container for contamination.
6. Dispose of uncontaminated packing materials as ordinary waste after removing or obliterating the radiation labels and ensuring that no contamination exists.
7. Contaminated packing materials are to be handled as radioactive wastes.
8. Record the receipt of the shipment and results of the survey. Complete the isotope delivery form.
9. If everything is in order, deliver the package to the user.

The user will:

1. Sign for the package upon delivery to the laboratory. Verify contents.
2. Check for contamination before disposing of any packing materials delivered with the shipment.
3. Handle contaminated packing materials as radioactive wastes.
4. Obliterate or remove any radiation labels on packaging materials prior to disposal.
5. Record the receipt of the shipment.

### **2.6.3 Records to Be Maintained**

Most records required by State or Federal regulations are maintained by the RSO. Some required records cannot be maintained there, however; and this Section describes these records and suggests a satisfactory method for maintaining them.

One of the records to be maintained by UMKC is the quantity of radioactive material authorized by the RSC and possessed by the users. For Federally-controlled byproduct material, UMKC is authorized to possess and use specific quantities of these materials with the aggregate of all such materials not to exceed a specific limit. Thus, the current inventory of each radionuclide and the aggregate sum of these individual items must not exceed the limits set by the license. This aggregate sum includes those radio-nuclides being held as wastes.

The RSO maintains a listing of the quantities of each radionuclide which have been authorized by the RSC for use by individual users. This record ensures that excesses of the maximum amounts are not authorized by the RSC without an opportunity to seek an amendment to the license from the NRC to increase the possession limit for the specific radionuclide. Details of the day-to-day possession and use picture must be maintained also. These details can only be maintained in the using laboratory.

An individual user must keep a record of the receipt, use, storage, and disposal of radioactive materials so that he can, at any time, calculate the amount on hand. For those users using a sealed source, an adequate inventory need only be an accessible record of the date of receipt of the material with a reasonably accurate assay of the quantity. With these data, he can then estimate the quantity remaining at any future time by a simple calculation of the exponential decay. The user receiving a shipment of material that is to be introduced *in toto* into an experiment also has a relatively simple task. His inventory need consist only of the pertinent data of receipt of the material and the date of introduction into the experiment. From that point in time, the quantity on hand is the quantity in the experiment; and unless some material is lost from the experiment, the quantity on hand at any future time is the original amount reduced by radioactive decay.

Radioactive materials used in human subjects, for the purpose of diagnosis or therapy, require an inventory record before and after the materials are administered. Such materials used in research applications in humans or in laboratory animals must be accounted for during all of the time the material is under the control of the user. Thus, records must show the quantity received, the quantity administered to the subject, the quantity eliminated by the subject and what was done with

it, and the quantity remaining in the subject.

The user serving his collaborators as a dispensing agent is the one who has a difficult recordkeeping task. While material transferred to another user is no longer the responsibility of the dispensing agent, a record must be kept of the transfers; and the new custodian is obliged to keep track of the material from that point on. Meanwhile, the dispensing agent may have had several such transfers from a single shipment, and he must be prepared to show what has happened to the entire amount, including what has been lost by radioactive decay and what has been disposed of as radioactive waste. All transfers of radioactive materials from one authorized user to another must be done with DRS approval.

A form, **RadSafe 11**, Quarterly Inventory Form, has been developed upon which the inventory record may be kept. A copy of this form may be found in **Section 11.0**. Each user is required to submit a quarterly inventory to the RSO.

#### **2.6.4 Waste Disposal Procedures**

Most of the information about disposal of radioactive wastes of importance to the individual user is contained in **Section 4.0**. The only method of disposal left to the discretion of the user is that by release to the sanitary sewerage system, and this is limited to quantities released incidentally to cleaning glassware. All other disposal methods must be accomplished by or under the supervision of the RSO. Additionally, any material transferred to the RSO for disposal is to be identified as to radionuclide, form, quantity of radioactive material, and hazardous waste category in accordance with the UMKC's Chemical Management Plan. Such a record should be made in the user's inventory log as well.

The types of radioactive wastes generated at UMKC include a variety of solids and chemical and biological solutions. Radioactive wastes will be segregated from nonradioactive wastes, by radionuclide and form and by hazardous chemical content, in the generating laboratories. Radioactive wastes will be accumulated in the laboratories in proper containers as recommended by the RSO. Radioactive wastes may be accumulated in steel, plastic or fiberboard drums, one-gallon plastic bottles, and in cardboard cartons.

Low Level Radioactive Waste Handling Procedures:

1. When radioactive or mixed wastes have accumulated in sufficient quantity or activity level to be collected, the user will fill out the Radioactive Waste Pick Up Form, **RadSafe 13**.
2. The user must indicate on the form the radionuclide, form and activity for each container of radioactive wastes in addition to any hazardous chemicals contained in mixed wastes so that proper labeling, recording and disposal of the wastes may occur.
3. The authorized user must send the form to DRS.
4. Upon receipt of the form DRS personnel will complete the Radioactive Waste Pick Up Form and generate the necessary labeling and manifesting, if necessary, in order that the wastes may be collected and disposed of. For mixed wastes, required DOT labeling will also be generated.
5. An appropriate radiation survey will be performed on the waste when picked up. The waste is assigned to a storage site in the CBARS Storage Building until decayed or disposed of by the disposal methods permitted by regulation and by license conditions. A number is assigned to each waste pickup. The number, date, user, isotope, quantity and form are recorded in the Master Radioactive Waste Log.
6. Radioactive Waste Pick Up Form is signed and dated after recording all applicable data and placed in a notebook.
7. Radioactive wastes are periodically surveyed or analyzed with appropriate monitoring and/or analyzing equipment. All wastes equivalent to the system background dose rate or count rate are disposed of 1) solids to the normal trash system after removal or obliteration of all radioactive material labeling and 2) liquids to the sanitary sewerage system.
8. Those wastes that cannot be disposed of as in 7 above will be properly packaged for shipment to a commercial disposal facility.
9. Final disposition of all radioactive wastes is entered in the Master Log and on the Radioactive Waste Pick Up Form.

#### **2.6.5 Posting of Warning Signs and Notices**

Parts of the State and Federal regulations with which UMKC must comply stipulate a system of warning signs and

notices to be posted. Samples of these warning notices are available from the RSO. A copy of the current version of the **Form NRC-3, "Notice to Employees,"** must be posted in every laboratory using radioactive materials licensed by the NRC. This form is to be posted so that every employee of the laboratory can read it conveniently. It need not be posted on a departmental bulletin board, however, as such a location will expose it to a wider audience than is intended. Copies of this form may be obtained from the RSO.

Rooms in which radioactive materials are to be used on a routine basis need to be identified by affixing to the entrance doors a warning sign containing the words "Caution-Radioactive Material" and including the three-bladed radiation symbol. Other wording appropriate to the use of the room may be added, but nothing less than these words with the symbol is acceptable. Irrespective of the presence of the warning labels, the user shall secure the material from unauthorized access. If, within a room, the radioactive material is normally kept within a closet and the material is brought into the room for short periods only, the closet door should have the warning sign affixed and the door to the room may be left unmarked. Rooms in which radioactive materials have been used and which have been posted with warning signs but are no longer used for this purpose do not need warning signs, they must be removed. This removal will take place normally when the RSO performs a "close out" survey to confirm that the space may be released for unrestricted use. Copies of these warning signs are available in various sizes from the RSO.

Containers in which radioactive materials are stored need to be labeled as to radionuclide, form, quantity and hazardous chemical content and these containers shall also have affixed the standard "Caution-Radioactive Material" label. Since the quantity contained will change with time, the label should show the date of assay of the original quantity. Containers such as beakers, test tubes, flasks, and similar devices need not be labeled as long as the radioactive material kept in them is used transiently and the user is present during the time the material is being used.

An "Emergency Procedure" appropriate to the work in the laboratory shall be posted and its contents made known to all personnel of the laboratory. This procedure may be constructed from the general comments of **Section 2.0**. But, however it is generated, it must provide the names and telephone numbers of all persons and departments to be contacted in the case of an emergency. Copies of a generic "Emergency Procedure" are available from the RSO.

Special labels are required by State regulation to be affixed to x-ray generators. A sample of this label is available from the RSO. This label shall be placed at or near the control panel so that it is clearly visible to a person attempting to operate the controls.

### **2.6.6 Leak Testing of Sealed Sources**

All sources of radioactive material, whether byproduct material or not, which have been encapsulated to prevent the escape of the contained material shall be checked within six-month intervals to ensure the integrity of the containment. Sealed sources designed for the purpose of emitting alpha particles shall be tested for leakage within three-month intervals. Foils for gas chromatographs and containers of radioactive material in gaseous form are not considered to be sealed sources. To provide for a uniformity of testing procedures and to ensure compliance with the Federal and State regulations pertaining to sealed sources, the RSO will leak test every sealed source on a schedule that satisfies the regulation. These leak tests will also satisfy a license condition that requires a physical inventory every six months to account for all sealed sources and/or devices received and possessed under the license. Reports of these leak tests will be forwarded to the user, and copies will be distributed as necessary.

## **2.7 CRITERIA OF HEALTH PHYSICS COVERAGE**

### **2.7.1 General**

A determination of adequacy of radiation safety coverage or even the determination of what constitutes radiation safety coverage are questions answered by the circumstances at hand rather than by contrived generalizations. Standards for adequacy are non-definite. Rather, they are based upon the qualification of people using the materials and upon the relative risk of the operation. Of these considerations neither can be defined rigidly, nor can exact yardsticks be applied to the measure of control achieved. Absolute control of radiation hazards is possible but only by eliminating all sources of radiation. As soon as use is permitted, absolute control becomes impossible. What we must seek to do is to achieve reasonable control without stifling legitimate use. As restrictions on individual use are relaxed, the difficulties in achieving control are increased. The degree of control achieved within UMKC is measured by the RSO when visiting laboratories on routine inspections. A prescribed procedure is followed to assess the adequacy of the user's methods of use of materials. This procedure includes an assessment of radiation exposure rates, contamination levels, individual exposure records, security and labeling of radioactive materials, inspection of radiation safeguards, reviews of inventory records, qualifications of associates, and so on. Discrepancies are noted and reported to the user on a standard form.

Specific recommendations are made to improve the methods and to achieve control, when necessary. No instance of non-cooperation with these recommendations has been experienced. If such a negative response were ever experienced, the investigator would be warned that he must comply or risk termination of his authorization. No facility in which radioactive materials are actually used will be free of noncompliance items. Control is a relative quantity, and only the repetition of minor items or the existence of major items of noncompliance suggests a lack of control.

### 2.7.2 Risk-Level Classification

All rooms in which sources of radiation are used by an investigator are assigned a risk-level classification to establish a radiation safety inspection frequency. An inspection by the RSO is in addition to that provided routinely by the user. UMKC utilizes a modified laboratory classification/design specification scheme for radionuclide laboratories based on **IAEA Safety Series No. 1, "Safe Handling of Radionuclides, 1973 Edition."** The modified scheme is based upon radiotoxicity of the radionuclides in use, ranging from low, moderate, high to very high and the general design specifications of Type A, B and C laboratories.

Nuclide Type of Laboratory Required for Group\* Levels of Activity Specified Below#

	Type C	Type B	Type A
1	<10 $\mu$ Ci	<10 mCi	>10 mCi
2	<100 $\mu$ Ci	<100 mCi	>100 mCi
3	<1 mCi	<1 Ci	>1 Ci
4	<10 mCi	<10 Ci	>10 Ci

\*Table I. Radionuclides Classified According to Relative Radiotoxicity per unit activity, **IAEA Safety Series No. 1.** Minimum significant quantities 1, 10, 100 and 1000 microcuries, Groups 1-4, respectively.

# Type C: Good quality chemical laboratory

Type B: Specially designed radioisotope laboratory

Type A: Specially designed radioisotope laboratory for handling large amounts of radioactive materials.

The modifying factors contained in **Section 2.0** may be applied to the quantities indicated in the last three columns of the table above.

A special group of laboratories are those rooms used for storage of sealed sources or for use of H<sup>3</sup> or Ni<sup>63</sup> foils in gas chromatographs with no other radioactive material present. The sealed sources are leak tested within six-month intervals and this serves to satisfy the inspection requirement.

Among the sources of radiation not covered by the Federal regulation but for which some control must be provided nevertheless because of the risk potential are the many x-ray machines in use. Once installed, these machines have essentially constant radiation characteristics and do not need to be inspected more frequently than once each year. It should be noted that the risk-level classification is not related directly to the "Classification of Degree of Hazard" chart. Many factors are involved in the risk-level classification and only one of them is the relative hazard described by the chart. A really more important consideration is the attitude of the user toward the maintenance of radiation safety in his laboratory. A careless or unconcerned user can easily transform a minor risk into a major risk, and his laboratory will be inspected more frequently. If more inspections are inadequate to control the situation, a recommendation will be made to the RSC to terminate the authorization.

#### Notes

1. Report No. 30 "Safe Handling of Radioactive Materials" of the National Council on Radiation Protection and Measurements (NCRP) published March 9, 1964. The RSO should be consulted for identification of latest reference sources.

2. Report No. 35 "Dental X-Ray Protection" published March 9, 1970, Report No. 49 "Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energy up to 10 MeV" published September 15, 1976 and Report No. 102 "Medical X-Ray, Electron Beam and Gamma Ray Protection For Energies Up to 50 MeV (Equipment Design, Performance and Use) published June 30, 1989 contain recommendations for radiation shielding.

3. In keeping with the definition used by the National Council on Radiation Protection and Measurements, the verb **shall** denotes that the ensuing recommendation is necessary or essential to meet the currently accepted standards of protection and **should** indicates advisory recommendations that are to be applied when practicable.

4. Type of containment is not important except that the liquid and the material of the container must be compatible so that corrosion will not occur. Liquids containing tritium present a special problem since the tritium in gaseous form may diffuse through some materials such as polyethylene.
5. Laboratory apparel monitored and found to be contaminated shall not be sent to a commercial laundry. Consult with the RSO: if contaminated apparel can not be salvaged, it must be handled as radioactive waste.
6. Uncontained is defined to mean a condition in which a substantial surface area is exposed to the environment such as, for example, the surface of a liquid in a beaker. If the compound is supplied by the vendor in a vial and is transferred to a syringe by aspiration and the operation is conducted within a functioning fume hood, the compound is considered to be contained and the bioassay requirement does not apply.
7. Continuous contact is intended to mean through the working hours of a total period greater than one week.

### 3.0 PROCEDURE FOR LABORATORY INSPECTION

#### 3.1 GENERAL

This Procedure is the development of the DRS staff serving the authorized users of UMKC as coordinated with the RSO as specified in **Section 1.0** of the Handbook. To maintain uniformity of inspection techniques and recording practices, this Procedure will be followed as closely as possible within the restraints imposed by the special circumstances encountered at each laboratory. Variations in techniques and practices are to be negotiated with the RSO to ensure a maximum degree of uniformity. Proposals for these variations are to be accompanied by supporting justification to explain why the variations are necessary and how the data to be obtained are considered equivalent.

It is assumed in this Procedure that instruments appropriately designed for the measurements to be made are available, in good working order, and are calibrated against reference sources of radiation essentially equivalent in properties to those being measured. Survey instruments used on the campus are calibrated at least annually and after repair. Operational checks of the survey instruments are performed prior to each use to ensure proper operation. When applicable, check sources are used before each use of the instruments to verify response to radiation.

Inspections of laboratories in which radionuclides are used are completed by the DRS personnel and signed by the RSO as outlined in **Section 1.0** of the Handbook and in compliance with the requirements of **10 CFR 20**. For each location, the DRS personnel become familiar with the conditions of the materials license covering operations at the location and with all appropriate sections of **10 CFR 19**, **10 CFR 20**, and other parts of the Code of Federal Regulations as they apply. Results of these inspections are reported on the Radiation and Area Contamination Survey Form, **RadSafe 12a**, (hereinafter Survey Form) supplemented by the Laboratory Survey Check List Form, **RadSafe 12b**, (hereinafter Check List Form). **RadSafe 12b** need not be completed each time **RadSafe 12a** is used, nor is it necessary to respond to every item on that form each time it is used.

DRS personnel will survey and inspect all laboratories using uncontained radioactive materials quarterly. Additional surveys will be performed as required by the risk-level classification, regulations and safety requirements. The surveys will include area radiation levels and removable contamination measurements in the restricted and surrounding areas. Air sampling will be performed if air concentrations are suspected of being in excess of the applicable **10 CFR 20** limits.

Authorized users will be required to perform documented surveys after each day of use of uncontained radioactive materials in a laboratory. Daily surveys are not required in laboratories in which sealed sources are used in gas chromatographs, in gamma or liquid scintillation counters. Surveys of the work area should be performed at the completion of a radioactive material use session, e.g., experimental run, work period or end of the day. The surveys shall include wipes of surfaces to evaluate removable contamination levels. Area exposure rate measurement must be obtained when gamma or medium to high-energy beta emitters are in use. Surveys must be documented by a written, signed and dated entry in a log book. Usually five to ten survey locations are sufficient to document a survey of a radioactive material use area. The counting system used for wipe analysis must have an efficiency posted for the radionuclide(s) in use. Survey meters must be operational and should have been calibrated within the past year.

Individuals using millicurie quantities of  $^{32}\text{P}$  must use a low density shielding barrier, e.g., Plexiglas, in order to minimize the bremsstrahlung radiation. A mandatory radiation and contamination survey must be performed after each use of  $^{32}\text{P}$  involving more than one millicurie and ring badge dosimeters must be used for these procedures. A dry run of procedures utilizing  $^{32}\text{P}$  shall be conducted in the presence of the RSO prior to the initial use. The RSO will supervise all new RSC approved procedures involving the use of any and all radioactive materials.

Leak tests and physical inventories of sealed sources are completed by DRS personnel as required by conditions of UMKC's materials license. These leak tests are to be performed at intervals not to exceed six months for sealed sources containing  $\beta$ ,  $\gamma$  or neutron emitters and every three months for sealed sources designed to emit  $\alpha$  particles. Results of these leak tests are reported on the Report of Leak Test of Sealed Sources Form. If it is uncertain whether or not a specific source is a "sealed source" requiring a leak test, it should continue to be leak tested until a definite determination can be made by inquiry to the NRC. For the purposes of satisfying this condition of the license, a radioactive material is a "sealed source" only if the NRC defines it as such in accordance with the definition contained in **10 CFR 30**.

#### 3.2 LABORATORY SURVEYS

Prior to the visit to the laboratory, DRS personnel will review the authorization file of the user and the reports of previous inspections. A sketch of the laboratory facilities may be found in the file record, or one can be made during the inspection of the laboratory. This sketch is made on the Survey Form to approximate scale; only the principal features of

the laboratory need be recorded and these only in an outline. Other basic information is recorded on both the Survey and Check List Forms before the inspection is performed. Contact is made with the user to advise him/her of the schedule of the inspection and to invite him/her to participate.

A review of the reports of previous inspections prior to the inspection visit will encourage a recollection of the details of the past inspections and will permit a visualization of specific items to look for in the next inspection. Of particular interest are the recommendations made previously to determine that they have been followed and corrective actions have been taken. For example, if a specific recommendation was made to improve the inventory record, special attention needs to be given to determine that the recommendation was followed.

### 3.2.1 Preliminary Procedure

Upon arrival at the laboratory, the DRS personnel will review the following items with the user, if he/she is available, or someone else familiar with the operations of the laboratory should be sought to respond to these items.

- Availability of Survey Instruments and Record of Use. As required by **Section 2.0** of the Handbook, each laboratory shall have a survey meter or laboratory monitor readily available to it that is capable of detecting radiations from the radioactive materials in use. Check the operational status of the instrument. Review the maintenance, calibration, and use log for proper entries. Note any significant radiation dose rate measurements or other anomalies in the "Comments" portion of the Check List Form.

- Proposed Use and Special Equipment. Note any significant changes or deviations from those stated in the application and the authorization for use. This involves a value judgment of the evidence presented that the user is doing what he/she said in his/her application he would do. For example, are there needs for special equipment dictated by the use which are not available, such as: glove box, remote pipette, secure storage facility, and so on?

- Inventory Records. The log book maintained by the user is examined for proper entry of receipt, use, transfer, decay, or disposal of radioactive materials. Data may be reported on the Quarterly Inventory Form, **RadSafe 11**. Each authorized user is accountable for any release of radioactive material to the sanitary sewerage system. As specified in **Section 2.0**, no release in excess of that resulting from washing of glassware is permitted. Liquid-form radioactive materials are collected by DRS personnel for disposal elsewhere. Special instructions in methods to minimize release to the sanitary sewerage system are provided by the RSO and the user is reminded of the release limit of one curie per year for the entire campus. Check the security of stored radioactive materials. The RSO will maintain an inventory of the radioactive materials in use.

- Area Contamination Control. Review all procedures for handling radioactive materials from receipt to disposal. Check for availability and proper use of radioactive waste containers, absorbent paper, protective trays, and other suitable items.

- Posting and Labeling. Determine if the proper signs are posted on the entrances to the laboratory, the fume hood, the storage area, and on equipment and containers. Verify that a recently issued version of **NRC Form-3** and Emergency Procedures are posted.

- Personnel Monitoring. Use of film badges for personnel monitoring in each laboratory must be evaluated in terms of the information received. If previous records of film badge monitoring reflect no significant exposures, if the laboratory inspection yields no significant radiation or contamination levels, and if the use of the radioactive materials authorized for the laboratory is such that a significant exposure is unlikely, consider canceling all personnel monitoring for the laboratory. If this step is taken, consider the use of film badges permanently affixed to the wall, bench top, or other suitable locations to serve as area monitors.

- Training. A Statement of Training and Experience for Use of Radiation Sources, Radiation Worker Form, **RadSafe 5**, for each associate employed in the laboratories who actually handle the radioactive materials authorized must be on file. If not, the absence of this record is to be recorded under "Comments," and the necessary steps are to be taken to obtain this information in collaboration with the authorized user.

Record any other pertinent information in the "Comments" portion of the Check List Form. This is the place to note positive comments as being pleased with the inventory records or being pleased that previous contamination levels had been reduced or eliminated.

### 3.2.2 Survey Procedures

## Radiation Survey

For laboratories in which radionuclides emitting both medium to high energy  $\beta$  particles and  $\gamma$  radiations are authorized for use, the radiation survey is to be performed with a Geiger-Mueller survey meter equipped with a side-window ( $<30$  mg/cm<sup>2</sup>) hand probe with a rotatable  $\beta$  shield or an instrument of another type having an equivalent sensitivity to  $\beta$  and  $\gamma$  radiations. For those laboratories in which radionuclides emitting only  $\beta$  particles are used, the survey meter should be equipped with a thin-end-window ( $<2$  mg/cm<sup>2</sup>) hand probe or a pancake hand probe. For laboratories in which radionuclides emitting  $\alpha$  particles are used, the survey is performed with an instrument sensitive to  $\alpha$  particles. In performing a survey, special attention is given to the following locations: enclosures for storage, fume hood, glove box, solid-waste container, liquid-waste container, all working surfaces, and the floor around each of these components. If all dose rates are equal to the recorded background dose rate, the following statement may be entered in the "Radiation Survey" column on **RadSafe 12a**: "All D.R. = background D.R. of \_\_\_ mrem/h". Exceptions to this will be identified by capital letters, A,B,C,..., on the sketch of the room layout with the dose rate corresponding to each location entered in the "Radiation Survey" column on **RadSafe 12a**. Identify the survey instrument used by make and serial number. Identify the survey instrument used: Make, Model, Serial Number, detector type and calibration date.

## Contamination Survey

Evaluation of the wipes collected in laboratories is performed on calibrated instrumentation capable of detecting the radiations emitted. DRS currently uses a gas-flow-proportional counter for evaluation of medium to high energy  $\beta$  emitters. Wipes from laboratories using low energy  $\beta$  emitters, as well as medium to high energy, and some low energy  $\gamma$  emitters are evaluated with a liquid scintillation counter. Wipes from laboratories using  $\alpha$  emitters are evaluated with the gas-flow-proportional counter. DRS has access to a gamma well counter if needed.

The wipe sample for removable contamination is taken from an area of approximately 100 cm<sup>2</sup> using filter paper discs suitable for the dimensions of the counting device. In some instances, it may be desirable to moisten the paper disc with a detergent solution to enhance the collection efficiency. To prevent cross contamination among samples, wipes are kept separated and labeled.

When performing a contamination survey, special attention is given to the locations examined in the radiation survey where higher radiation exposure rates were obtained and also to laboratory entrances and exits. Locations where wipe samples were taken are identified on the sketch of the room layout by a circled number 1, 2, 3,... Results of the evaluation of all smears are reported in dpm or pCi of removable contamination per 100 cm<sup>2</sup>. If the evaluation of the samples indicates the absence of removable contamination, the following statement may be entered in the "Contamination Survey" column of **RadSafe 12a**: "All wipes less than 110 dpm/100 cm<sup>2</sup> above background." Exceptions to this are identified by the appropriate location number and the dpm or pCi of removable contamination per 100 cm<sup>2</sup> noted. Identify the detection system used to evaluate the wipes. The sensitivity of the detection system should be retained on file and periodically checked.

## Fume-Hood Air Flow

The air flow of fume hoods in which radionuclides are used is measured with the fume hood sash one-half open. The face velocity of the fume hood should be measured under conditions of actual use and provide a uniform air flow of at least 100-linear-feet per minute. The value is recorded on **RadSafe 12b**. Exceptions to the minimum airflow rate are noted in the "Comments" portion of the form. Identify the instrument used to measure the air flow. While measuring the air velocity, examine and evaluate the materials of construction of the hood for adequacy to the use employed.

The requirement of a minimum airflow rate in fume hoods can be modified at the discretion of the RSO upon evaluation of the kind, quantity and form of the radionuclides being used and upon the evaluation of the type of experiment being performed. A more definite measure of the adequacy of the fume hood as a safety device is the lack of evidence of removable contamination in the vicinity of the hood. The RSO must be mindful of the hazards of an airflow rate that is too high when the sash is lowered. Newer hoods with bypass air flow and shaped portals will contain the quantities of radionuclides normally found with a flow rate as low as 50-linear-feet per minute, if used carefully.

Evaluate the radioactivity concentration in the fume hood exhaust by dividing the maximum activity potentially airborne by the volume flow rate through the fume hood face. If the MPC<sub>air</sub> is likely to be exceeded at the exhaust, consider what needs to be done to reduce the effluent concentration to less than MPC<sub>air</sub> values. The RSO should know the location of each fume hood exhaust, should post it with an appropriate label, and should periodically check the occupancy factor in the immediate environs of each. In some instances, a particulate or gaseous filter (or both) may need to be installed to reduce the concentration at the exhaust. The RSO, finding this condition, will limit the use of the hood until the filter is



installed.

### Air Sample and Bioassay

In compliance with **10 CFR 20** and during the laboratory inspection, an air sample is collected whenever the radionuclides in use can be suspended in air in sufficient quantities to pose an inhalation hazard, that is: a substantial fraction of the  $MPC_{air}$ . The Staplex Hi-Volume air sampler, or equivalent, is used to collect the sample and is operated for at least ten minutes. If a high-volume sampler is not available, a low-volume sampler can be used but must be operated for a longer length of time, perhaps one hour or more depending on the flow rate. If a radionuclide such as I-131 is present, a filter or cartridge containing activated charcoal is used in place of or in addition to the particulate filter.

The times at the start and completion of the sampling, the average airflow rate, and the activity, in  $\mu Ci/cm^3$ , are recorded in the "Notes" column of the **RadSafe 12a**. A 24-hour recount is taken to determine if activities other than short-lived, natural radioactive materials are present, and these results are also recorded in the "Notes" column. If the recount indicates activity levels above  $MPC_{air}$  values, the laboratory supervisor is to be notified and an analysis of the contaminants present is to be made. A recount of the same sample is taken again one week later to ensure the absence of long-lived contaminants unless their absence is established otherwise.

Whenever the air sample contains radioactive material in excess of a substantial fraction of the  $MPC_{air}$ , a bioassay of a suitable specimen (thyroid count, nasal wipe, urine, feces, etc.) may be required for all personnel who have been exposed to the contaminated air. The possible need for a bioassay will be determined by the RSO. Results of these bioassays, even if negative, are to be recorded in the personnel monitoring records of the individuals involved. To the extent that airborne contamination by the radioactive material in use reflects loss of control, remedial steps to restore the control are to be taken as soon as possible.

### 3.3 LEAK TEST OF SEALED SOURCES

The leak test should be performed with filter paper discs or with cotton-tipped applicators, depending upon the source activity, configuration, and containment. The source should be rubbed firmly with the filter paper discs held with tongs or forceps or with cotton-tipped applicators, to remove any surface contamination. The source holder should also be wiped. When access to the sealed source is prevented by the construction of the device, the wipes should be taken as near the source as possible. Each disc or applicator is placed in a separate envelope appropriately labeled for identification. Evaluations of wipes taken from sealed sources containing a  $\beta$ -emitter are made with a gas-flow proportional or liquid scintillation counter. Evaluation of wipes taken from sealed sources containing an  $\alpha$ -emitter are made with a gas-flow-proportional counter. If the results of the test indicate removable contamination in excess of 0.005 microcuries, the source is taken from service immediately and held in secured storage until it can be decontaminated and repaired. Results of leak tests are reported on **RadSafe 8**.

### 3.4 REPORTS

The results of the inspection, as reported on **RadSafe 12a**, **RadSafe 12b** and **RadSafe 8**, are mailed to the user as soon as possible after completing the evaluation of the inspection. If the inspection reveals conditions that require correction, a follow-up survey is made after a reasonable period of time has elapsed. However, if the conditions are such that immediate attention must be given to them, a member of the DRS shall immediately notify the user and assist in correcting the situation.

In preparing the report of an inspection, the RSO must weigh carefully the information he has accumulated to determine the content of a specific recommendation to the investigator. That is, it is not sufficient merely to report radiation levels in mrem/h or contamination levels in  $pCi/100\text{ cm}^2$ . These numbers may also provide a measure of the response of the user to UMKC regulations and to the general recommendations made to him in the Handbook. The RSO can decide whether or not the user is doing all he can be expected to do to maintain a radiation-safe condition in his laboratory. If he is doing all he can be expected to do, he should be so advised with respect to the particular features of his program by appropriate comments on **RadSafe 12b**. If he is not doing these things, the RSO should convey, to the user, his specific recommendations for improvement.

The RSO will develop a sense of adequacy of radiation safety in each laboratory after he has visited the same laboratory several times and can compare present conditions with those of the past and further compare these conditions with those found in other laboratories. This buildup of experience with the conditions in the laboratory and with the response of the user to recommendations for correction of unsatisfactory conditions permits the RSO to make value judgments that need not be tied to an arbitrary scale of unsafe conditions. Removable contaminations of  $10\text{ pCi}/100\text{ cm}^2$  of a weak  $\beta$ -emitter in one laboratory may reflect a greater lack of attention to good practice than a removable contamination of  $100\text{ pCi}/100$

cm<sup>2</sup> of a  $\beta$ -emitter found in another laboratory. At the same time, the RSO must not allow his increasing familiarity with a laboratory or with the user to permit a gradual trend toward increased radiation or contamination levels. Acceptable laboratory practice should be evident and where found should be made known to the user with the same persistence with which poor practice is reported.

### **3.5 REVIEW AND ADJUSTMENT OF THIS PROCEDURE**

The RSO must be mindful of the transitory nature of this Procedure; its content merely provides a place to start. Whenever operating experience dictates modifications or enlargements of the parts of this Procedure, the information with appropriate supporting documentation is to be reported to the RSO who, in turn, will disseminate the information if appropriate. In this way, the Procedure can be maintained as a viable and renewable document.

## 4.0 RADIOACTIVE WASTE DISPOSAL PROGRAM

### 4.1 GENERAL

All radioactive wastes resulting from the use of radioactive materials in UMKC laboratories shall be disposed of in a manner to prevent the occurrence of a hazard to the health of personnel, to the value of property, or to the welfare of the community. Safe disposal is to be accomplished by the RSO by holding for decay, by disposing of limited and strictly controlled quantities into the sanitary sewerage system or by repackaging for subsequent shipment to a commercial disposal facility. Radioactive wastes, both liquid and solid, resulting from the use of radioactive materials in laboratories, except small quantities released to the sanitary sewerage system, **shall** be stored in designated, properly marked, containers and retained for collection by the RSO. Solid wastes are to be stored in special containers obtained from the RSO and liquid wastes are to be stored in metal or plastic containers, with double containment as recommended by the RSO. Volume reduction of all wastes has become more important as the costs of disposal have increased rapidly and because of the need to protect our environment. Volume reduction begins at the user level when the decisions are made as to the quantities and types of material to purchase. Volume reduction is the first consideration for disposal of radioactive wastes, and this consideration must be applied when the experiment is designed.

Radioactive waste material collected from each laboratory will be stored and retained for a sufficient interval to permit the decay of short-lived constituents. Ultimately, all wastes that cannot be disposed of by radioactive decay or release into the sanitary sewerage system will be shipped to a commercial disposal facility. Radionuclides requiring a "Radioactive Materials" label may be stored only in specifically designated areas and must be protected against fire, explosion, or water damage. The areas must be locked and under the control of responsible individuals. Documentation must be available listing all radionuclides present, the activity as of a specified date, and the originator of that material. Flammable material requiring refrigeration must be stored in explosion-proof refrigerators. If flammable materials are stored, they should be placed in metallic containers. A fire extinguisher must be located nearby. Adequate shielding must be provided.

### 4.2 UMKC WASTE HANDLING FACILITY

A facility intended for use by all units of UMKC for the storage and disposal of radioactive wastes has been established on the Volker Campus. This facility provides for both long-term and short-term storage, collection of waste prior to shipment for commercial burial or incineration of very low-level radioactive wastes, compaction of wastes, container storage, and for other unanticipated needs as they arise. A temporary storage facility for radioactive wastes is located at the School of Medicine. Use of UMKC vehicles is preferred for transporting radioactive wastes, but consideration of use of a commercial carrier need not be excluded. When a UMKC vehicle is used, the following conditions **shall** be satisfied:

■ **CONTAINMENT:** Solids **shall** be transported in drums lined with plastic inserts. Liquids **shall** be packed and transported in sturdy cardboard cartons and placed inside a drum lined with two plastic liners (3 mil or thicker) along with sufficient absorbent material to absorb at least twice the quantity of liquid placed in the drum. Animals or biological tissues **shall** be frozen prior to packing in the drums. Drums **shall** be sealed shut before loading onto the truck. Occasionally, special packaging may be required.

■ **SURVEYS:** The drums and truck **shall** be surveyed by the RSO before transport on public roadways. A dose rate measurement **shall** also be taken in the cab of the truck. All containers shipped **should** have dose rate readings of <200 mrem/h at any point on accessible surfaces and <10 mrem/h at three feet from any external surface. There **shall** be no significant removable contamination (1) on the exterior surface of the containers. The driver of the truck **shall** be furnished with a pocket dosimeter or other type of personal dosimeter by the RSO. When dose rate readings exceed the levels cited above, exterior shielding **shall** be positioned and secured to reduce radiation levels to at least the levels cited. If the vehicle is occupied by individuals who are classified as radiation workers, the dose rate **shall** not exceed 2 mrem/h in any occupied area of the vehicle.

■ **IDENTIFICATION OF SHIPMENT:** Each container of waste **shall** be identified by attaching a DOT White I, Yellow II or Yellow III label containing the following information: radionuclides contained, associated activities, the Transport Index, the date the drum was filled, and the name of the person completing the label. In the case of mixed wastes, the required, State, EPA and DOT transport information **shall** also be attached. The container will also be labeled as required by **10 CFR 20** and **49 CFR**. A shipping manifest **shall** be prepared listing the number of packages the contents of each in terms of radionuclides and associated activities, physical forms, hazardous chemicals for mixed wastes and date transported. One copy **shall** be kept by the RSO and one copy **shall** be given to the driver.

### 4.3 RESPONSIBILITIES OF THE RSO

The responsibility for the coordination of collection, storage, and ultimate disposal of laboratory wastes contaminated with radioactive materials is assigned to the RSO to provide single-point control of contamination. He will provide for the control of all radioactive wastes that have been collected from using laboratories. To achieve this control, all disposal by decay, release to air or water, or by shipment to a commercial disposal facility **shall** be performed by the RSO.

#### 4.3.1 Laboratory Wastes

The RSO will supply the laboratory with fiberboard drums of 12- or 28-gallon capacity with plastic liners or other suitable containers in a quantity such that one or more containers will be available to each laboratory. These containers will be labeled "Caution Radioactive Material." Pickup service will be provided for collection of wastes at the request of the laboratory supervisor and submittal of a properly completed Radioactive Waste Pick Up Form, **RadSafe 13**, following the instructions provided by **RadSafe 13b**, Radioactive Waste Pick Up Form Instructions.

#### 4.3.2 Campus Storage

UMKC **shall** provide facilities for storage of radioactive wastes prior to ultimate disposal. Material is to be stored until a sufficient quantity is accumulated to warrant shipment to a commercial disposal facility.

#### 4.3.3 Available Methods of Disposal

Wastes will be separated and stored according to chemical hazard, physical form (liquid or solid) and a half-life to facilitate the disposal procedures outlined below.

Disposal To the Sanitary Sewerage System:

Disposal into the sanitary sewerage system is to be accomplished by, or specifically approved by, the RSO. To ensure that the limit of **10 CFR 20** is not exceeded the following maximum limits, for the sum of all radionuclides except tritium and carbon-14, is 1.0 Curie/y. The following limits apply specifically and separately to tritium and carbon-14, respectively, 5.0 Curie/y and 1.0 Curie/y.

Liquids disposed of through the sanitary sewerage system must also meet the other requirements of **10 CFR 20** and should be limited to those quantities that can not be economically disposed of by other methods. Radioactive material released by laboratory personnel **shall** be limited to that occurring incidentally with slightly contaminated wash water from cleaning laboratory glassware. Liquid wastes from laboratory experiments are to be collected as liquids for disposal by the RSO or they are to be converted to solid form for disposal into a radioactive waste container. Any uncertainty about this method of disposal **shall** be addressed to the RSO for clarification or for assistance in establishing alternative methods.

Shipment to Commercial Facility:

Any wastes not disposed of locally are shipped to licensed commercial disposal facilities. Such wastes include solid material like wipes, filter papers, contaminated clothing, aprons, absorbent counter covers, and so forth. Liquid wastes **shall** be reduced, if possible, to a minimum volume and converted to a solid form or bulked for disposal. Solid and liquid waste material **shall** be shipped in DOT approved containers in accordance with applicable DOT regulations and the requirements of the disposal site to which the material is shipped. The RSO will be responsible for the management of such shipments to commercial disposal facilities.

### 4.4 RESPONSIBILITIES OF THE LABORATORY SUPERVISOR

Collection and storage of wastes within the laboratory are the responsibility of the laboratory supervisor. He will ensure compliance with applicable regulations and maintain control of radioactive wastes until such accumulated wastes are removed by the RSO. He will also segregate and properly label all radioactive and mixed waste materials.

#### 4.4.1 Wastes Accumulated for Collection

The laboratory supervisor **shall**

- Ensure that all radioactive materials (and only such materials) are placed in containers designated for such waste

- Ensure that all sharp objects (hypodermic needles, broken glass, etc.) placed in a puncture resistant containers so that they can not project through the drum liner
- Ensure that radioactive wastes are not removed by unauthorized personnel
- Ensure that waste materials are segregated according to whether solid or liquid and placed in proper containers. Liquid wastes **shall** be provided with double containment as recommended by the RSO. Mixed wastes should be separated from non-mixed wastes.
- Notify the RSO when waste materials are to be collected
- Be present when the RSO collects the waste material, so that the tags may be verified as to identity of the radioactive or hazardous chemical contents. The RSO **shall** not remove wastes from a laboratory which are not identified properly.

#### 4.4.2 Wastes to be Disposed of in a Laboratory

Radioactive wastes in liquid form **shall** not be disposed of into the sanitary sewerage system from any laboratory within UMKC. The single exception permitted is the release of trace amounts contained incidentally in the rinse water resulting from the washing of contaminated glassware. All other liquid-form wastes are to be accumulated for collection by the RSO as explained above in **Section 4.0**, or such wastes are to be transformed into a solid for collection by the RSO. Problems of disposal created by this constraint are to be discussed with the RSO so that a disposal method most convenient for the user can be arranged.

#### 4.4.3 Disposal of Animal Carcasses Containing Radioactive Material

Most of the work at UMKC involving the use of animals in experimental studies with radioactive material is conducted with small animals such as rats. When these small animals are sacrificed, they may be stored under refrigeration until it is convenient to dispose of them. Larger animals may not be stored so conveniently. For disposal of carcasses containing radioactive material, the following general guidelines are recommended:

- If the animal is small, the half-life of the radioactive material is short, and refrigerated storage is available, the carcasses **should** be stored long enough to ensure that the remaining radioactivity is negligible. After storage, the carcasses **should** be incinerated, if permissible. In case the radioactive material is concentrated within a single organ or localized system, the organ or system may be removed and kept in refrigerated storage until reduced in activity by decay to a level that may be incinerated. The remainder of the carcass may be incinerated after removal of the organ or system that contained the radioactivity and after the remaining carcass has been determined to be free of radioactive contamination.
- If the animal is small and the half-life of the radioactive material is long, or refrigerated storage is not available, the carcasses **should** be incinerated promptly, provided that the Maximum Permissible Concentrations in air are not exceeded. The RSO must be contacted to arrange for the incineration. If these carcasses can not be incinerated, it will be necessary for the RSO to ship them to a commercial disposal facility.
- If the animal is large and the half-life of the radioactive material is short, and refrigerated storage is available, the carcasses **should** be stored long enough to ensure the remaining radioactivity is negligible. After storage, the carcasses may be cut up and incinerated. If uncertain about residual activity, obtain a confirmation from the RSO.
- If the animal is large and the half-life of the radioactive material is long, or refrigerated storage is not available, the radioactivity may be removed if it has concentrated in a single organ or localized system. If such removal can be accomplished, two pairs of rubber gloves **should** be worn and removed tissue handled with forceps. The removed tissue **shall** be stored in an appropriately shielded area to which access can be controlled. If such removal is accomplished, the remainder of the carcass **shall** be surveyed for the presence of residual radioactivity. If no significant radioactivity remains, the carcass may be cut up and incinerated. If sufficient removal of activity can not be accomplished, it will be necessary to contact the RSO to ship the carcass to a commercial disposal facility.

The guidelines given above are not expected to cover every instance of the need for disposal of carcasses containing radioactive material. The user is requested to contact the RSO to assist in the resolution of any disposal problem not covered by these guidelines.

#### 4.4.4 Disposal of Animal Excreta Containing Radioactive Material

A rather complex problem of radioactive waste disposal results from the use of radioactive material for *in vivo* experiments with animals. The complexity derives from the uncertainty of the quantity and the rate of elimination from the animal, the knowledge of which may even be part of the experiment being conducted. Despite these uncertainties, the user must be prepared to collect, dispose of, and record the quantity of radioactive material contained in all excreta of experimental animals to which radioactive materials have been administered.

The methods by which he proposes to accomplish these tasks are to be made a part of his "Application for Possession and Use of Radiation Sources," as described in **Section 5.0** of this Handbook. Without attempting to specify the methods to be employed in every case, the following general guidelines will serve to outline what needs to be done.

- An estimate **shall** be made of the portion of the administered quantity of radioactive material that is expected to be eliminated by the animal.
- From this estimate, the significance in terms of potential hazard to personnel or property of the eliminated material can be evaluated. As a rule-of-thumb, if the total quantity eliminated per day from the entire group of experimental animals is <10% of the values listed for the particular radionuclide in **Appendix C, 10 CFR 20**, the elimination will not constitute a significant hazard to personnel or property.
- If the evaluation of the potential hazard indicates that a significant quantity is to be eliminated, an adequate method of collection of all excreta must be developed. If a significant activity cannot be excreted, the material may be disposed of through normal channels after an evaluation confirms that the excreta are not radioactive.
- After collection of the excreta, the best method of disposal must be determined. The user may elect to hold the material in an isolated storage area until a sufficient time has passed to reduce the activity to negligible levels. Upon a determination that the residual activity is negligible, the collected excreta may be released to the sanitary sewage system.
- If the material can not be held for radioactive decay or be released to the sanitary sewer, the disposal must be performed by or under the supervision of the RSO. When this determination has been made, the RSO **shall** be notified so that an acceptable disposal procedure may be specified.

#### 4.4.5 Disposal of Gaseous-Form Radioactive Wastes

A few experiments require the maintenance of a breathing environment for plants or animals containing a radioactive material in gaseous form. In all instances, such experiments **shall** be designed so that the gaseous form, radioactive material is contained within an enclosure exhausted to the atmosphere at concentrations less than the maximum permissible amounts specified in **10 CFR 20**. If several radionuclides are released, the limit for the combination may be derived by determining the ratio between the quantity present in the combination and the limit allowable when it is the sole constituent. The sum of the ratios determined in this matter for each of the constituents may not exceed unity. Records of all releases to air **shall** be maintained. If a release has, or may have, exceeded the limits specified above, the RSO **shall** be promptly notified so he may make a determination as to whether a notification is required to be sent to the NRC, and if so, to submit all necessary information in a report within the time limits specified by NRC.

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#### Notes

1. Significant contamination is defined as: removable beta or gamma activity >100 pCi/100 cm<sup>2</sup> or removable alpha activity >10 pCi/100 cm<sup>2</sup>.

## 5.0 GENERAL INSTRUCTIONS

## 5.1 APPLICATION FOR USE OF RADIATION SOURCES

Use of byproduct, source, and special nuclear materials by UMKC personnel is authorized by the materials license issued by the NRC. Control of these uses is dictated by the Federal regulations and by the conditions of use placed upon the materials license. Use of other radioactive materials and sources of radiation is authorized in a general sense by the Missouri Division of Health. Licenses are not issued by the State, but use is controlled by the Missouri Radiation Protection Regulations. Applications for use of radiation sources by UMKC personnel shall be reviewed and approved by the RSC by the mechanisms described in **Section 5.0**. Radioactive materials, including general license and otherwise exempt quantities, shall not be used within UMKC without prior approval.

### 5.1.1 Guidelines for All Applications

As the designated responsible party in several byproduct, source, and special nuclear materials licenses, the Curators must ensure that such materials as procured for use under these materials licenses are used in a manner that is completely safe and without hazard to personnel or property. As explained in **Section 1.0**, the Chancellor has delegated to the RSC the authority to control the issuance of authorizations for the use of radiation sources covered by the UMKC materials license as well as those covered by State regulations. Before a radiation source can be used, an application must be approved by the RSC and an authorization for such use must be issued in the name of RSC by the RSO.

A critical step in the review process is the determination that the training and experience of the applicant are adequate to conduct the proposed investigation in a safe manner. Such a determination is critically dependent upon the proposed use, since the kind and quantity of radioactive material or a radiation source coupled with the way it is to be used specifies the degree of the hazard. (See the discussion of relative hazard contained in **Sections 2.0**.) What the applicant hopes to accomplish by use of licensed materials in his/her experiment is not an issue in the evaluation of the application. Except for an evaluation of an application for an *in vivo* experiment in human subjects for which the reviewing quorum may suggest alternative solutions or methods to obtain the same information, the technical validity or substance of the proposed experiment is left to others to judge. Each application for an authorization to use a radiation source must contain a complete statement of the applicant's training and experience in addition to the statement of the kind, quantity, and proposed use of the source. The RSC in its review of the application determines whether or not the statement of training and experience is consistent with the use of the source that the applicant has specified. In view of this consideration, it is to the applicant's advantage to limit the proposed use to the smallest quantity and simplest form possible to accomplish the desired result.

Qualifications of associates are also of concern to the RSC performing the review of the application. Each person who will be in direct contact with the radiation source being requested needs to be qualified by appropriate training and experience to handle it safely. As explained in **Section 5.0**, a review of the application by the RSC will include a consideration of the qualifications of associates.

Training sufficient for the proposed use may be obtained by the applicant from a formal training course, from a preceptorship arrangement by which the training is acquired by working under the supervision of an experienced person, or from collaboration with an experienced person by whom applicable experience from another technique may be expanded to include the safe use of a radiation source. All of these methods of acquiring training and experience are available to interested UMKC personnel. The necessary ingredients of acceptable training are the following:

- Principles and practices of radiation safety
- Radioactivity measurements, standardization, and monitoring techniques
- Calculations basic to the use and measurement of radioactivity
- Biological effects of radiation.

In addition to the training requirement, the applicant must show that sufficient experience has been acquired in the safe handling of the radiation source for which application is made.

Results of the RSC review of the applicant's training and experience may take many forms. The most obvious case is that the applicant has had acceptable training and experience in the same or very similar type of use as is proposed, and the application can be approved without reservation. Another common situation is one in which the applicant has had training and experience suitable for a large variety of problems but not enough for the use which is proposed. This application can be approved with the condition that another authorized user supervise the use of the radiation source on a

temporary basis. The preceptor must have had acceptable training and experience for the proposed use, and assumed the responsibility for ensuring the safe use of the radiation source. This responsibility continues until the preceptor can report to the RSC that, in his/her judgment, the applicant can proceed without further supervision. In preparation of the application, the user should name the preceptor, with whom previous arrangements have been made, so that approval of the application will not be delayed for the purpose of naming someone. This authorization will be issued in the name of the applicant with a preceptor named in a condition of the authorization.

For the situation in which a graduate student will utilize a radiation source in his research project, the application should be submitted in the name of the faculty advisor of the work, and the authorization will be issued to the faculty advisor. Of course, the faculty advisor must be qualified by training and experience. Thus, the responsibility for safe handling of the radiation source to be used in graduate research will be vested in the faculty advisor of the project; or if the faculty advisor is not qualified by training and experience, the responsibility will be vested in a third party named in the application who has agreed to supervise this portion of the research. If the graduate student has the requisite training and experience, he/she can file the application in his/her own names with the authorization issued to him/her, but it is preferred that the authorization be issued to a faculty or staff member.

At times it may be convenient for the RSC to identify a group of users as a single entity and issue an authorization for the entire group in the name of a single responsible person. For such a situation to remain in conformance with the conditions of the license and UMKC regulations, each user within the group must submit his credentials for participation to the RSC for review and approval. In this way each individual of the group is authorized to use a part of or the full complement of the radiation sources assigned to the group. When an application is submitted in the name of the group, the names of the members to use the sources are to be identified, but the authorization will be issued to the individual who has been named as the responsible person.

### 5.1.2 Approval of Applications

Applications for the use of any of these sources are submitted to the RSC through the RSO. (See **Section 1.2** for the description of the RSC structure.) Special forms for this purpose are **RadSafe 1** and **RadSafe 2**. Instructions for the completion of the forms are given on form **RadSafe 3** included with the others as part of a package obtained from the RSO. For an initial application, a signed copy of form **RadSafe 1** and a copy of form **RadSafe 2** must be submitted. Applications for amendments to existing authorizations may be made on form **RadSafe 1a** or by letter. See these RadSafe forms in **Section 11.0**.

Upon receipt of the completed application, the RSO will make an initial evaluation of the content to establish that resources are available to support the radiation safety aspects of the experiment, that no conditions of the license will be compromised by the experiment, and that the applicant has satisfied the intent of the UMKC regulations to safeguard health and property. At a meeting of an RSC quorum, the application and a recommendation regarding radiation safety considerations prepared by the RSO will be reviewed. If disapproved by the RSC, the application will be returned to the applicant with an explanation of the action including a recommendation as to corrective action needed. When approved by the RSC, the application will be signed and dated by the chairperson and forwarded to the RSO for issuance of an authorization.

For the situation in which the applicant is assisted in a significant way by one or more associates, the qualifications of these associates to handle the sources safety shall be described as a part of the application. The description is to be provided on form **RadSafe 5**. The content of this form is equivalent to the statement of training and experience completed by the applicant on form **RadSafe 2**. Upon receipt of the application from the applicant, the RSO will review these statements of qualifications of the associates, and he will include his appraisal of them with his recommendations to the RSC. Any uncertainties about these evaluations shall be resolved by the RSC. When the submitted application is approved by the RSC, the applicant will be notified by the RSO and, subsequently, will receive an Authorization for Possession and Use of Radiation Sources, **RadSafe 4**, from the RSO indicating the response to the application. The effective date identified on the form will be the date of receipt by the RSO. Usually, the applicant is authorized to possess and use the radioactive materials requested. Occasionally, in the interest of radiation safety, the RSC will add restrictions on the use to ensure compliance with current Federal and State regulations. The RSC bears the responsibility to ensure that approval of an application will not compromise UMKC's commitment to the radiation safety program. The RSO will review each approved application before issuing the authorization to ensure that no commitment is compromised. This review step may result in an amendment to the action taken by the RSC.

## 5.2 RECORDS TO BE MAINTAINED



DRS will maintain records of bills of lading, inspection and delivery forms for radioactive materials. These records will be available for audits and NRC inspections. To satisfy the Federal and State regulations, UMKC must have available for inspection a reasonably current record of all radioactive materials in use. These records cannot be maintained by the DRS because, by their nature, they must represent a dynamic condition of new supply, use, disposal, and radioactive decay. The individual user shall, therefore, keep a current inventory of all radiation sources for which he is responsible, and he shall keep this record in a form that permits a convenient review by the RSO for the RSC or by a representative of the NRC. This requirement of the regulations can be satisfied by a simple bookkeeping procedure on forms supplied by the DRS, which should not entail much of the time of the investigator. The DRS will require a quarterly report of the sources on hand.

With respect to byproduct material, the Federal regulations and the conditions incorporated in the licenses stipulate maximum amounts in the possession of the licensee at any time. To satisfy this requirement, UMKC as licensee must have a positive mechanism to ensure that possession limits are not exceeded. This is accomplished by limiting the accumulated totals of any category of radioactive material authorized for use to less than the possession limit of the license. That is, if every user possesses the total amount his authorization allows, the accumulated total will still be less than the possession limits of the license. A record of these possession limits will be maintained by the DRS.



**SECTION 6.0 RADIATION SAFETY EMERGENCY PROCEDURES****RADIATION SAFETY EMERGENCY PROCEDURES****Fire Involvement**

1. Call the Police Department immediately at (816) 235-1515 or 911 from a campus telephone as they will contact the KC Fire Department. **DO NOT CALL THE KC FIRE DEPARTMENT.**
2. Notify the laboratory supervisor.
3. Notify all persons not involved in the fire to vacate the area. Allow no one to enter the contaminated area.
4. Notify the DRS by telephone at (816) 235-1844, (816) 235-5289 or (816) 235-1819, or by pager: (816) 435-9831, (816) 435-9834 or (816) 435-9830.

**Major Spills**

1. **CLEAR THE AREA.** Notify all persons not involved in the spill to vacate the area. Prevent entry into the area by unauthorized personnel. Retain all personnel involved in the spill until the DRS can monitor them for possible contamination.
2. **PREVENT THE SPREAD.** Use absorbent material to limit the spread but do not attempt to clean it up.
3. **SHIELD THE SOURCE.** If possible, the spill should be shielded, but only if it can be done without further contamination or with significantly increasing your radiation exposure.
4. **CALL FOR HELP.** Notify the DRS immediately by telephone or pager. Notify the laboratory supervisor.
5. **CLEAN UP THE SPILL.** Clean up the spill and decontaminate personnel with supervision provided by the DRS.
6. **MONITOR.** Monitoring of personnel and the area involved will be provided by the DRS.

**Minor Spills**

1. **CLEAR THE AREA.** Notify all persons not involved in the spill to vacate the area. Prevent entry into the area by unauthorized personnel. Retain all personnel involved in the spill until the DRS can monitor them for possible contamination.
2. **PREVENT THE SPREAD.** Use absorbent material to limit the spread.
3. **SHIELD THE SOURCE.** If possible, the spill should be shielded, but only if it can be done without further contamination or with significantly increasing your radiation exposure.
4. **CALL FOR HELP.** Notify the DRS and the laboratory supervisor.
5. **CLEAN UP THE SPILL.** Carefully clean up the spill; insert all cleanup materials into a plastic bag for disposal.
6. **MONITOR.** Survey the area around the spill, your hands, your feet, and your clothing for contamination.

**DRS TELEPHONE NUMBERS: (816) 235-1844, (816) 235-5289 or (816) 235-1819**

**\*DRS DIGITAL PAGER NUMBERS: (816) 435-9831, (816) 435-9834 or (816) 435-9830.**

\*Dial pager number. Hear a ring and a beep. Enter the number you want called. Hang up.



**SECTION 7.0 UNSECURED RADIOACTIVE MATERIALS LABORATORY POLICY****UNSECURED RADIOACTIVE MATERIALS  
LABORATORY POLICY**

1. If a Division of Radiation Safety staff member finds an open, unattended radioactive materials laboratory, the laboratory will be closed and locked upon exiting. A verbal notice of the occurrence will be given to the AU via voice mail which will state the date and time of the unsecured laboratory observation.
2. If a Division of Radiation staff member observes the same radioactive materials laboratory open and unattended a second time during the term of the Authorized User's authorization (three years), a written notice will be given to the Authorized User which will again state the date and time of the unsecured laboratory observation. The laboratory will be closed and locked upon exiting. A copy of the written notice will be sent to the Authorized User's supervisor.
3. Should there be a third observance of an unsecured laboratory after the written notice, the radioactive materials shall be removed from the laboratory by the Division of Radiation Safety staff member and held for retrieval by the Authorized User. Written notice of the action taken will be left at the time of the removal of the radioactive materials. Procedures for regaining possession of the material will be outlined in the written notice. A copy of this written notice will be sent to the Authorized User's supervisor.
4. If another occurrence of an unsecured laboratory is observed during the term of the authorization, the Radiation Safety Committee may impose sanctions upon the Authorized User, which may include probation for a time not to exceed one month, during which radioactive materials may not be obtained or used. Further occurrences may result in permanent termination of the authorization to use radioactive materials at UMKC.

A quarterly report of unsecured laboratories will be made to the Radiation Safety Committee. The Committee may request that the Authorized User present a plan to the Committee, in person or in writing, to ensure the security of radioactive materials in the laboratory.

## **DIVISION OF RADIATION SAFETY UNSECURED RADIOACTIVE MATERIAL LABORATORY PROCEDURE**

### **REPORTING PROCEDURE:**

1. A first observation of an unsecured RAM laboratory will be reported via voicemail to the Authorized User involved. A record of the time and date of the observation will be made by the Division of Radiation Safety staff member.
2. A second observation of the same unsecured radioactive materials laboratory will result in a written notice to the Authorized User. A completed copy of the "Notice of Unsecured Radioactive Materials Laboratory" form will be sent to the Authorized User, to the Authorized User's supervisor and a copy retained in the Division of Radiation Safety.
3. A third observation of the same unsecured radioactive materials laboratory shall result in a Division of Radiation Safety staff member removing the radioactive materials from the laboratory. A completed copy of the "Notice of Removal of Radioactive Material From an Unsecured Laboratory" form will be left in the laboratory at the time of removal of the radioactive materials. A copy of the original form will be sent to the Authorized User's supervisor and a copy retained in the Division of Radiation Safety to be used as record of transfer of the radioactive materials back to the Authorized User.
4. Another occurrence may result in sanctions imposed by the Radiation Safety Committee. The radioactive materials shall be removed from the unsecured radioactive materials laboratory.

### **TRANSFER OF RADIOACTIVE MATERIAL BACK TO AUTHORIZED USER:**

1. The Authorized User must contact the Radiation Safety Officer to arrange for return of the radioactive material.
2. The Division of Radiation Safety staff member returning the radioactive material will use the original "Notice of Removal of Radioactive Materials From an Unsecured Laboratory" form for a record of transfer back to the Authorized User. The signature section on the lower half of the form shall be completed at the time of the transfer back to the Authorized User.

### **STORAGE OF RADIOACTIVE MATERIAL:**

1. Radioactive material removed from an unsecured laboratory will be stored appropriately in a Division of Radiation Safety controlled refrigerator or freezer at CBARS controlled locations.

## **NOTICE OF UNSECURED RADIOACTIVE MATERIALS LABORATORY**

The following room was found unsecured on \_\_\_\_\_ (Date & Time)

Room : \_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
(CBARS Staff Member)

\*\*\*\*\*

Comments: (e.g., access point...)

Notice # \_\_\_\_\_

# NOTICE OF REMOVAL OF RADIOACTIVE MATERIAL FROM AN UNSECURED LABORATORY

The following radioactive material was removed from Room # \_\_\_\_\_

on \_\_\_\_\_ . The room was unsecured.  
(Date & Time)

RAM: \_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
(CBARS Staff Member)

\*\*\*\*\*

To regain possession of this radioactive material, contact the Division of Radiation, Office of CBARS, (816) 235-1819 or (816) 235-5289.

The above radioactive material was transferred on: \_\_\_\_\_ (Date)

\_\_\_\_\_  
(DRS)

\_\_\_\_\_  
(Authorized User)

\*\*\*\*\*

Comments: (e.g., access point, DRS stopped by radiation worker in hallway...)

Notice # \_\_\_\_\_



## 8.0 ACRONYMS AND DEFINITIONS

This section contains some of the Definitions and Acronyms used in Radiation Safety and in the Handbook of Radiological Operations:

### ACRONYMS:

ALARA:	As Low As Reasonably Achievable
AU:	Authorized User
CBARS:	Office of Chemical, Biological and Radiation Safety
cpm:	counts per minute
DOT:	Department of Transportation
dpm:	disintegrations per minute
dps:	disintegrations per second
DRS:	Division of Radiation Safety, CBARS
efficiency:	$\text{cpm} \div \text{dpm}$
HP/Asst HP:	Health Physicist/Assistant Health Physicist
IAEA:	International Atomic Energy Agency
MPC:	Maximum Permissible Concentration
NCRP:	National Council on Radiation Protection and Measurements
NRC:	Nuclear Regulatory Commission
PD:	Procurement Department
PO:	Purchase Order
PON:	Purchase Order Number
PR:	Purchase Requisition
RAM:	Radioactive Material
RSC:	Radiation Safety Committee
RSO:	Radiation Safety Officer
SI:	International System of Units

### DEFINITIONS:

Absorbed Dose:	The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the SI unit, the gray (Gy)
Activity:	The rate of disintegration of radioactive material. The units of activity are the Curie (Ci) and the SI unit, the becquerel (Bq)
Adult:	An individual 18 or more years of age
ALARA:	It means making every reasonable effort to maintain exposures to ionizing radiation as far below the permissible dose limits as is practical consistent with the purpose for which the licensed material is being used
AU:	An individual who is approved by the RSC to acquire, possess and use radiation sources. An AU is responsible for the safety of any individuals who use the radiation sources under his/her supervision
Background Radiation:	Radiation from natural sources, e.g., cosmic radiation and naturally occurring RAMS, and from man made sources, e.g., medical and dental radiation, fallout, etc. Background radiation does not include radiation from regulated byproduct, source or special nuclear materials
becquerel:	SI unit of activity equal to 1 dps
Bioassay:	The determination of radionuclides, activities or concentrations, and in some cases, locations of RAM in the human body, whether by direct measurement ( <i>in vivo</i> counting) or by analysis and evaluation of materials excreted or removed from the human body
Byproduct Material:	Any RAM (except special nuclear) made radioactive by exposure to the radiation incident to the operation of a nuclear reactor
Curie:	Unit of activity equal to 37 billion dps
Declared Pregnancy:	When a woman has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception and delivery
Dose Equivalent:	The product of the absorbed dose in tissue and a quality factor. The units of dose equivalent are the rem and the SI unit, the sievert (Sv)
Dose Limit:	The upper bound of dose equivalent permitted by regulation. Dose limit includes the sum of the external and internal dose equivalents
Emergency:	Any incident resulting from the use of radiation sources that presents an external or internal hazard to

Exposure:	personnel. Common incidents are spills, fires in laboratories or loss or theft of RAM Condition of being exposed to x or $\gamma$ radiation. The unit for exposure is the Roentgen (R) and the SI unit, the Coulomb/kg
External Dose:	That portion of the dose equivalent received from radiation sources outside the body
Extremity:	The arm including from the elbow to the hand and the leg including from the knee to the foot
Eye Dose:	External dose equivalent to the lens of the eye at a tissue depth of 0.3 cm
gray:	SI unit of absorbed dose. One gray is equal to 100 rads (1 Joule/kg)
Internal Dose:	That portion of the dose equivalent received from RAM inside the body
Lab Supervisor:	An individual approved to possess and use hazardous chemicals in accordance with the Chemical Management Plan
Licensed Material:	RAM received, possessed, used, transferred or disposed of under a general or specific license issued by the NRC or an Agreement State
Licensee:	The holder of a materials license. For UMKC, it is the University of Missouri Board of Curators
Member of the Public:	Any individual not occupationally exposed to radiation sources
Minor:	An individual less than 18 years of age
Mixed Waste:	Waste that contains both RAM and hazardous chemicals
Monitoring:	Radiation protection monitoring is the measurement of radiation and contamination levels and the use of the results to evaluate potential hazards or exposures
Non-ionizing Radiation:	Radiation such as radio- or microwaves, visible, infrared or ultraviolet light
Occupational Dose:	The dose equivalent received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation sources. Occupational dose does not include doses received from background radiation, from medical procedures or from voluntary participation in medical research programs or as a member of the public
rad:	Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/g or 0.01 Gy
Ionizing Radiation:	Alpha and beta particles, gamma rays, x-rays, neutrons, high-speed electrons and protons, and other particles capable of producing ionizations
Radiation Area:	An area, accessible by individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in one hour at 30 cm from the radiation source or from any surface that the radiation penetrates
RSO:	An individual qualified by training and experience in radiation protection and is available to give advice and assistance on radiation safety matters to employees of a licensee
Radiation Sources:	Any material or device that produces ionizing or non-ionizing radiation
Radiation Worker:	An individual using radiation sources under an AU's supervision. This individual must meet certain educational, training and experience requirements
rem:	Unit of dose equivalent. One rem is equal to the product of the absorbed dose in rads and a quality factor. One rem is equal to 0.01 Sv
Sealed Source:	Any RAM that is encased in a capsule designed to prevent leakage or escape of the RAM
sievert:	SI unit of dose equivalent. One sievert is equal to the product of the absorbed dose in grays and a quality factor. One Sv is equal to 100 rem
Survey:	An evaluation of the radiological conditions and potential hazards incident to the use, transfer, release, disposal or presence of RAM or other radiation sources.

## SECTION 9.0 INFORMATION

This section contains information that may be helpful in establishing your radiation/contamination working levels and emergency response procedures.

### RADIATION/CONTAMINATION GUIDES

The following Radiation/Contamination Guides, action levels and procedures will be used by authorized users in their laboratories unless modified in consultation with the RSO:

#### REMOVABLE CONTAMINATION LEVELS (GENERAL AREAS)\*

<50 pCi/100 cm<sup>2</sup> (110 dpm/100 cm<sup>2</sup>) above background - No action indicated

50-5k pCi/100 cm<sup>2</sup> (11k dpm/100 cm<sup>2</sup>) See clean up of minor spills in the Emergency Procedures and contact DRS for clean up advice and support

>5k pCi/100 cm<sup>2</sup> (>11k dpm/100 cm<sup>2</sup>) See clean up of major spills in the Emergency Procedures and contact DRS for clean up advice and support.

\*Controlled and posted localized work surfaces, e.g., fume hoods, trays, shields, etc. may be higher by a factor of ten than these listed guides but **not** centrifuges used for both radioactive and non-radioactive procedures.

#### EXPOSURE RATES, END-WINDOW GM SURVEY METER

At close proximity to a contamination spot

<0.1 mrem/h (<120 cpm) No action indicated

0.1 to <1.0 mrem/h See clean up of minor spills in the Emergency Procedures and contact DRS for clean up advice and support

1.0 to 10.0 mrem/h See clean up of major spills in the Emergency Procedures and contact DRS for clean up advice and support

>10.0 mrem/h Contact DRS immediately for clean up advice and support.

#### GENERAL AREA EXPOSURE RATES (WHOLE BODY EXPOSURES)

<1.0 mrem/h Acceptable radiation level and no action indicated

1.0 to <5.0 mrem/h Restricted areas, control and limit personnel access

>5.0 mrem/h **RADIATION AREA** and DRS should be contacted for advice and correct area posting

>100 mrem/h **HIGH RADIATION AREA** and DRS should be contacted for advice and correct area posting.

**ACTION LEVELS****A. RADIATION**

## 1. Area Radiation Levels

<0.05 mrem/h	Background
<1.0 mrem/h	Acceptable levels, unrestricted
1.0 to <5 mrem/h	Restricted areas, controlled access
>5.0 mrem/h	Radiation Area
>100 mrem/h	High Radiation Area.

## 2. Surface Measurements/Personnel or Equipment

<0.1 mrem/h	Release as not contaminated
0.1 to <1.0 mrem/h	Contaminated - label or decontaminate
1.0 to <10 mrem/h	Grossly contaminated - remove from service and decontaminate
10 to 100 mrem/h	Highly contaminated - may be radiation hazard to personnel.

**B. CONTAMINATION**

1. Unrestricted areas, personal clothing      2000 dpm/100 cm<sup>2</sup> for all  $\beta$ - $\gamma$  emitters  
except 200 dpm/100 cm<sup>2</sup> for Iodine isotopes
2. Restricted areas, protective clothing, skin of body      20,000 dpm/100 cm<sup>2</sup> for all  $\beta$ - $\gamma$  emitters  
except 2000 dpm/100 cm<sup>2</sup> for Iodine isotopes

**C. PERSONNEL EXPOSURE**

1. Whole body      Level I - 125 mrem/calendar quarter  
Level II - 375 mrem/calendar quarter
2. Extremities      Level I - 1875 mrem/calendar quarter  
Level II - 5625 mrem/calendar quarter.

## DATA ON COMMON RADIONUCLIDES

**HYDROGEN-3:**  ${}^3_1\text{H}$  ( $T_{1/2} = 12.3$  y)  $\rightarrow$   ${}^3_2\text{He} + {}_{-1}\beta$   $E_{\text{max, ave}} = 18.6, 5.68$  keV

Maximum range in air: approx. 1/6 inch

Critical Organ: Total body water

Hazards: Externally: None in mCi quantities  
Internally: H-3 labeled DNA precursors  
H-3 labeled water

Measurement techniques: Contamination control: wipe test, LSC  
Internal exposure: bioassay

PRECAUTIONS: H-3 labeled compounds can penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently.

**CARBON-14:**  ${}^{14}_6\text{C}$  ( $T_{1/2} = 5730$  y)  $\rightarrow$   ${}^{14}_7\text{N} + {}_{-1}\beta$   $E_{\text{max, ave}} = 156, 49.5$  keV

Maximum range in air: approx. 8.6 inches

Maximum range in water: approx 0.28 mm

Critical Organ: Bone, Fat

Hazards: Externally: None in mCi quantities  
Internally: C-14 labeled  $\text{CO}_3^{2-}$  in bone

Other C-14 labeled compounds in fat

Measurement techniques: Contamination control: wipe test, LSC. Large quantities (waste storage areas) may possibly be seen with pancake probe equipped GM detectors.  
Internal exposure: bioassay

PRECAUTIONS: C-14 labeled compounds can penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently.  
C-14 labeled halogenated acids may be incorporated in the skin to give local doses of 10-100 rad per microcurie deposited.

**PHOSPHORUS-32:**  ${}^{32}_{15}\text{P}$  ( $T_{1/2} = 14.3$  d)  $\rightarrow$   ${}^{32}_{16}\text{S} + {}_{-1}\beta$   $E_{\text{max, ave}} = 1.71, 0.695$  MeV

Maximum range in air: approx. 20 feet

Maximum range in plexiglass: approx. 0.3 inches

Maximum range in tissue: 7 mm

Critical Organ: Bone, Total body

Hazards: Externally: Beta radiation exposure in contact with skin  
Internally: Transportable P-32 labeled compounds in bone  
Non-transportable P-32 labeled compounds in lung

Measurement techniques: Contamination control: wipe test, LSC, GM survey meters equipped with pancake probes. Lapel and ring dosimeters required for handling over 1 mCi)  
Internal exposure: bioassay

PRECAUTIONS: P-32 labeled compounds can penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently.  
Wear whole body and extremity dosimeters. Use plastic shielding to minimize Bremsstrahlung and exposure while handling P-32. Do not work over open containers.

Dose rates: At surface of 1 ml of solution of 1.0 mCi P-32 is about 13 rem/minute. A drop of P-32 on a square cm of skin could give a local dose rate of 2000 rem/hr-mCi.

**PHOSPHORUS-33:**  $^{33}_{15}\text{P}$  ( $T_{1/2} = 25 \text{ d}$ )  $\rightarrow$   $^{33}_{16}\text{S} + {}_{-1}\beta$   $E_{\text{max, ave}} = 250, \text{ keV}$

Maximum range in air: approx. 9.6 inches

Critical Organ: Same as P-32

Hazards: Externally: None in mCi quantities  
Internally: Same as P-32

Measurement techniques: Contamination control: wipe test, LSC. Large quantities may possibly be seen with GM survey meters equipped with pancake probes.  
Internal exposure: bioassay

PRECAUTIONS: P-33 labeled compounds can penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently.

**SULFUR-35:**  $^{35}_{16}\text{S}$  ( $T_{1/2} = 87.4 \text{ d}$ )  $\rightarrow$   $^{35}_{17}\text{Cl} + {}_{-1}\beta$   $E_{\text{max, ave}} = 167, 48.8 \text{ keV}$

Maximum range in air: approx. 9.6 inches

Critical Organ: Total body

Hazards: Externally: None in mCi quantities  
Internally: S-35 labeled compounds in total body

Measurement techniques: Contamination control: wipe test, LSC. Large quantities may possibly be seen with GM survey meters equipped with pancake probes.  
Internal exposure: bioassay

PRECAUTIONS: S-35 labeled compounds can penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently.

**IODINE-125:**  $^{125}_{53}\text{I}$  ( $T_{1/2} = 60 \text{ d}$ )  $\rightarrow$   $^{125}_{52}\text{Te} + \gamma$   $E_{\gamma} = 35 \text{ keV}; 27\text{-}32 \text{ keV x-rays}$

First half-value layer: 0.02 mm lead

Critical Organ: Thyroid

Hazards: See Precautions below.  
Externally: Small in microcurie quantities  
Internally: Doses to thyroid to be avoided

Measurement techniques: Contamination control: wipe tests (gamma counter or LSC), GM survey meter equipped with a scintillation probe (GM detector efficiency is low-0.01%)  
Internal exposure: thyroid scan

PRECAUTIONS: Volatilization is most significant problem; be aware of and control procedures that may generate aerosols. Solutions of iodide ions that are acidic or stored frozen lead to formation of volatile elemental iodine. *Avoid these situations.* Keep I-125 chemically stable by ensuring alkaline pH situations. Iodine-labeled compounds can easily penetrate skin and gloves. Wear two pairs of gloves, change outer pair frequently. As I-125 is a photon emitter, lead shielding is very useful in reducing external exposure. Note: RIA kits using radioiodine can be handled safely *-with reasonable care-* on the open bench not only because RIA kits build in some of the above precautions in their procedures, but also because of the small quantities of I-125 (<10 microcuries per kit) present.

## 10.1 GENERAL

UMKC personnel authorized to use RAMs may purchase them for use. AUs or designees may purchase only those RAMs permitted by their current authorization.

## 10.2 ORDERING RAMS

RAMs shall be ordered in accordance with the purchasing regulations defined by Procedure 03.06, **Purchasing Radioactive Materials** in the University's **BUSINESS POLICY AND PROCEDURES MANUAL**. The RAM purchasing information shall include the following:

- NRC License Number, 24-00513-37
- AU's Permit Number
- Radionuclide, form and quantity
- Vendor.

Each RAM purchase shall be approved by DRS before the order is placed with the Vendor.

RAMs shipments for Campus AUs will be delivered to:

- UMKC Central Receiving  
Attn: Division of Radiation Safety, x1844  
General Services Building  
1011 East 51st Street  
Kansas City, MO 64110.

RAMs shipments for Hospital Hill AUs will be delivered to:

- UMKC School of Medicine  
Attn: Division of Radiation Safety, x1844  
2411 Holmes Street  
Kansas City, MO 64108.

Special shipping instructions, if any, and the appropriate delivery address shall be provided to the Vendor. Credit Card orders, blanket orders, telephone orders and bid requests shall contain the same complete information and must be approved by DRS. If the same items are being shipped at specified times or at scheduled time intervals, no further notification to DRS is required after the initial approval. If shipments are to be made 'On Call' by the AU, then DRS must be notified by the AU when a shipment is requested so that delivery can be anticipated. Any 'free' shipments of RAMs must also be approved by DRS

## 10.3 DELIVERY OF RAMS

### 10.3.1 Delivery During Normal Working Hours

RAMs shipments shall be delivered to Central Receiving or the School of Medicine during normal working hours of 8:00 am to 4:30 pm, Monday through Friday. Central Receiving or the School of Medicine staff will notify DRS of the receipt of any shipment of RAMs as soon as possible.

### 10.3.2 Delivery During Non-Working Hours

At present, deliveries of RAMs to UMKC are not accepted or made during non-working hours. If this becomes a necessity in the future, these procedures will be amended.

### 10.3.3 Special Delivery and/or Authorized User Pickup

At present, RAMs shipments are not received during non-working hours and the AUs can not accept RAMs shipments at airline or truck terminals. If these modes of delivery become necessary in the future, these procedures will be amended. AUs cannot transport RAMs on public thoroughfares in their vehicles.

### 10.3.4 Inspection of RAMs Shipments

DRS shall inspect and monitor all RAMs shipments. The inspection will include a visual of the condition of the package and shipping labels. The bill of lading will be compared against the PR. A radiation and contamination survey will be performed on the package and its contents. The results of the survey will be recorded on the RAM Isotope Delivery Form. RAMs shipments found to have excessive radiation or contamination levels will be reported to the NRC and the carrier as required by regulations.

#### **10.3.5 Delivery of RAMs Shipments to AUs**

Delivery of RAMs shipments will be made to the AU's laboratory by DRS during normal working hours. The AU will be telephoned to ensure that someone authorized to accept RAMs will be available in the laboratory to receive the shipment. The receiver of the shipment will be required to sign the RAM Isotope Delivery Form signifying receipt of the shipment.

#### **10.4 RECORDS**

DRS will maintain records of bills of lading, inspection and delivery forms for RAM. These records will be available for audits and NRC inspections. AUs remain responsible for maintaining their own inventory records of receipt, use, transfer or disposal of all RAMs in their possession. These AU records are subject to inspection by DRS and any other regulatory agency.

#### **10.5 EXEMPTIONS OR EXCEPTIONS**

Each purchase of RAMs requiring an exemption or an exception from these procedures shall be considered individually by DRS. If exemptions or exceptions are allowed, they shall be done in a manner so as not to compromise the intent of these procedures.



## 11.0 FORMS

This section contains a listing of the forms used in the conduct of the radiation safety program. Those forms most commonly used by the Authorized Users are listed in **bold** and are found in this section. These forms may be copied for your use. The other forms are available from DRS.

1. **RadSafe 1, Application for Possession and Use of Radiation Sources**
2. **RadSafe 1a, Amendment Application for Possession and Use of Radiation Sources**
3. **RadSafe 2, Statement of Training and Experience for Use of Radiation Sources, Authorized User**
4. **RadSafe 3, Authorized User Application Forms, General Instructions for Application**
5. RadSafe 4, Authorization for Possession and Use of Radiation Sources
6. **RadSafe 5, Statement of Training and Experience for Use of Radiation Sources, Radiation Worker**
7. RadSafe 6, Authorization Renewal Form
8. **RadSafe 7, Laboratory Radiation Safety Orientation Checklist**
9. RadSafe 8, Report of Leak Test of Sealed Source
10. RadSafe 9, Radiation Worker Checklist
11. RadSafe 10, Radioactive Materials Delivery Form
12. **RadSafe 11, Quarterly Inventory Form**
13. **RadSafe 11a, Instructions for Completing Quarterly Inventory Form**
14. **RadSafe 11b, Example of Completed Quarterly Inventory Form**
15. RadSafe 12a, Radiation and Area Contamination Survey
16. RadSafe 12b, Laboratory Survey Check List
17. **RadSafe 13, Radioactive Waste Pick Up Form**
18. **RadSafe 13b, Radioactive Waste Pick Up Form Instructions**
19. RadSafe 14, Radioactive Materials Internal Transfer Form
20. RadSafe 15, Declaration of Pregnancy
21. RadSafe 16, Pregnancy Declaration Policy
22. RadSafe 17, Health Physics Evaluation.

**RadSafe 1 APPLICATION FOR POSSESSION AND USE OF RADIATION SOURCES**

1. Applicant Name \_\_\_\_\_ Degree \_\_\_\_\_  
 UMKC Position \_\_\_\_\_ Full Time \_\_\_\_\_ Other \_\_\_\_\_
2. Department \_\_\_\_\_ Office Phone \_\_\_\_\_
3. Laboratory No. \_\_\_\_\_ Lab Phone \_\_\_\_\_

**This form must be typed or printed neatly with black ink.**

4a. Source(s) to be used:	4b. Form:	5. Possession Limit Requested:
6. Proposed use and plan of investigation		
7. Plan for personnel monitoring and radiation protection		
8. Plan for disposing of radioactive wastes		
_____ As per procedures in the Handbook  Special procedures to be used:		
Health Physics Evaluation  Date received:  Date evaluated:  Risk-level classification:  _____ Health Physicist	Radiation Safety Committee Review  Date Received:  Date approved:  _____ Committee Chairman	9.  _____ / _____ Applicant /Date  _____ Department Chairman

Authorized User: \_\_\_\_\_

Authorization No. \_\_\_\_\_

Department: \_\_\_\_\_

Lab Rm. No.: \_\_\_\_\_

**This form must be typed or printed neatly with black ink.**

1a. Source(s) to be used:	1b. Form:	1c. Possession Limit Requested:
2. Proposed use and plan of investigation		
3. Plan for personnel monitoring and radiation protection		
4. Plan for disposing of radioactive wastes if different than the procedures in the Handbook		
<p>Health Physics Evaluation</p> Date received: Date evaluated: Risk-level classification:  _____ Health Physicist	<p>Radiation Safety Committee Review</p> Date received: Date approved:  _____ Committee Chairman	<p>5. Signatures</p> _____ Applicant  _____ Department Chairman

**RadSafe 2 STATEMENT OF TRAINING AND EXPERIENCE FOR USE OF RADIATION SOURCES  
AUTHORIZED USER**

Name of applicant:

Date:

Birth date:

Social Security Number:

Sex:

Type of training:	Where trained	Duration of training	Formal course (Check)	On-the-job (Check)
1. Principles of radiation protection				
2. Radioactive measurements techniques and instrument				
3. Math basic to radioactivity				
4. Biological effects				

Experience with Radiation Sources:

Source	Amount	Where Used and Duration	Type of Use
1			
2			
3			
4			

Experience with Radiation Detection Instruments:

Type of Instrument	Radiation Detected	Use
1		
2		
3		

Type and Quantity of Radiation Sources to be Used:

Date Recd:

Date Eval:

Applicant  
Signature:

DRS:

**RadSafe 3****GENERAL INSTRUCTIONS FOR COMPLETING  
AUTHORIZED USER APPLICATION FORMS**

Use of radiation sources by personnel at UMKC is authorized by material licenses issued to the Curators of the University Of Missouri by the U.S. Nuclear Regulatory Commission and by of the State of Missouri. Control of such use within UMKC is vested in the RSC by delegation of authority from the Chancellor and by conditions of the licenses.

Applications for the use of any sources of radiation are submitted to the RSC through the RSO. Special forms for this purpose are attached and detailed instructions for the completion of the forms are given below. For an initial application, a signed copy of RadSafe 1 and RadSafe 2 must be submitted. Applications for amendments to extant authorizations must be made on RadSafe 1a. RadSafe 5, the radiation worker form, must be completed for each individual working with radioactive materials in the authorized user's laboratory. Copies of the forms currently in use are enclosed.

**RadSafe 1, Application for Possession and Use of Radiation Sources**

1. Name, academic degree and UMKC position or title of the person who will be responsible for the safe handling of the radiation sources. The applicant must be experienced in the safe handling of radiation sources as evidenced by entries on RadSafe 2.
2. Indicate the department or subdivision having administrative responsibility for the radiation sources to be used and the office telephone number of the applicant.
3. The room number, campus building and the telephone number of the laboratory where the radiation sources will be used. Do not use an office address for this item. If the radiation sources are to be prepared within one campus building but actually used in another building, this should be explained in Item 6.
4. Each radiation source must be identified by type. If a radioactive material is listed, give the chemical symbol and the mass number. If a radioactive material is requested, the "form" is the description of the chemical and physical state of the material. The form, "any", is preferred.
5. The "possession limit" is the maximum quantity expected to be on hand at any time, in use, in storage and in waste, expressed in millicuries.
6. State briefly the use and plan of investigation for each radiation source and each chemical and physical form specified in Items 4 and 5, and for each distinctly different experimental protocol. Experimental protocols may be submitted in lieu of this statement. If additional space is needed, a second sheet may be attached. Please indicate the maximum quantity of radioactive material to be used per experiment.
7. State the plan to be used for personnel monitoring and radiation protection beyond the use of the lapel film badge and the ring badge which are issued routinely upon request. List any personnel monitoring instruments used in addition to the film and ring badges. Bioassays may be required for experiments involving tritium or iodine in uncontained form.
8. If the applicant follows the radioactive waste disposal program outlined by DRS, he/she needs merely check the indicated reference. If exceptions to the current procedure are expected, the applicant must outline these exceptions in detail.
9. Signatures and date of application. The applicant and his department chairperson or supervisor must each sign in the space provided. The signature of the department chairperson or supervisor is intended to indicate cognizance of the application and acceptance of whatever responsibilities for provision of resources are required by the intended use.

**GENERAL INSTRUCTIONS FOR COMPLETING**

**AUTHORIZED USER APPLICATION FORMS  
PAGE TWO**

**RadSafe 2, Statement of Training and Experience for Use of Radiation Sources, Authorized User**

10. All training pertinent to using radioactive materials or other radiation sources should be identified by the applicant on his/her first application. All training in specialty fields relating to use of the radiation sources requested should be included as appropriate. Please list formal courses completed that relate to any of the four topics in this section.
11. All pertinent experience with radioactive materials or other radiation sources should be included. **Also indicate pertinent experience with detection instruments. Summarize the type and quantity of Radiation Sources to be used by radionuclide and quantity.**
12. **On a separate page, please** list the radiation detection instrumentation available to the laboratory to be used for radiation safety support of the study described on RadSafe 1. If counting equipment not owned by the department, subdivision or applicant will be used, a signed statement by the individual having authority to allow usage of the counting equipment must be included. Experimental apparatus should not be described unless such apparatus also serves a radiation safety function.
13. Describe how radiation detection instruments are to be calibrated.
14. Information on shielded storage facilities, use of fume hoods or gloves boxes, beta shields, special handling apparatus and experimental procedures designed to reduce exposure to personnel, minimize contamination and safeguard the radiation sources should be described.
15. **A straight lined ruler sketch of the laboratory indicating the location of pertinent equipment and facilities must be submitted.**

**RadSafe 5 STATEMENT OF TRAINING AND EXPERIENCE FOR USE OF RADIATION SOURCES  
RADIATION WORKER**

Name of Radiation Worker:	Date:
Birth date:                      Social Security Number:	Sex:

Name of Authorized User:                      Department:

Type of training:	Where trained	Duration of training	Formal course (Check)	On-the-job (Check)
1. Principles of radiation protection				
2. Radioactive measurements techniques and instrument				
3. Math basic to radioactivity				
4. Biological effects				

**Experience with Radiation Sources:**

Source	Amount	Where Used and Duration	Type of Use
1			
2			
3			
4			

**Experience with Radiation Instruments:**

Type of Instrument	Radiation Detected	Type of Use
1		
2		
3		

**Type and Quantity of Radiation Sources to be Used:**

Rad Worker Location:	Rad Worker Signature:
Rad Worker Phone Number:	
Date Recd:                      Date Eval:	Authorized User Signature:
DRS:	

Worker name: \_\_\_\_\_ AU: \_\_\_\_\_

Lab Location \_\_\_\_\_

1. General Use of Laboratory \_\_\_\_\_

2. Radioactive Material Use in Laboratory:

Describe RAM used (type of emitter, chemical form and general procedures): \_\_\_\_\_

Check the following, if reviewed, or NA=not applicable:

- NRC Form 3 location       Recordkeeping
- location of paperwork       who's responsible for paperwork in lab
- RAM labeling procedures      Lab locations:  RAM storage  RAM use  RAM waste storage

3. Safety Precautions (check if reviewed, or NA = Not Applicable)

- gloves       lab coats       absorbent paper       trays
- areas of use defined       shielding used       hood use       wipe tests
- meter surveys       personnel monitoring

Other lab-specific safety precautions: \_\_\_\_\_

4. Emergency Procedures (check if reviewed, or NA = Not Applicable)

- General Procedures       Fire       Minor Spills       Major Spills
- Notifications       Emergency Procedure Posted       Incident Reporting Requirements

Other notes: \_\_\_\_\_

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

DRS Trainer: \_\_\_\_\_ Date: \_\_\_\_\_



Authorized User's Name: \_\_\_\_\_

Radioactive Materials Quarterly Inventory Printed:

Radio-nuclide	Compound	Vendor	Date Rec'd	mCi Rec'd	On hand mCi	In lab waste mCi	Σ mCi to CBARS

TOTAL INVENTORY:

Notes:

Waste Transfers during quarter:

DATE            Radionuclide            Amounts (indicate if transfer activity is decay corrected)

DATE \_\_\_\_\_ SIGNED \_\_\_\_\_

## RadSafe 11a INSTRUCTIONS FOR COMPLETING QUARTERLY INVENTORY FORM

1. Review the enclosed inventory printout entries. The columns appearing are as follows:
  - a) radionuclide
  - b) compound (may be abbreviated)
  - c) vendor (may be abbreviated)
  - d) date shipment received
  - e) activity received, in millicuries (mCi)
  - f) activity in laboratory still to be used, either in stock vials, in experimental setups, preparations or useful samples, in mCi
  - g) activity in lab waste, in mCi
  - h) total activity transferred to CBARS from this shipment (do not decay to correct this value)

**NOTE:** If you routinely decay correct your values for amounts on hand, please indicate this on the inventory form.
2. Record results of review:
  - a) If the entry is correct, place a check mark or an "x" in the left margin by the line item.
  - b) If a correction is required, make the correction directly on the form next to the entry by drawing a single line through the incorrect information, and writing in the correct information on the form.
  - c) If additions to your inventory have been made as of the date you perform your inventory, enter the appropriate information at the end of the list.
3. If you have transferred waste to CBARS during the quarter, review the waste transfer summary section.
  - a) If the entry is correct, place a check mark or an "x" in the left margin by the line item.
  - b) If a correction is required, make the correction directly on the form by the entry by drawing a single line through the incorrect information, and writing in the correct information on the form.
  - c) If a transfer has been made as of the date you perform your inventory, enter the information at the end of the list.
4. Sign and date the inventory form in the spaces provided.
5. Return the inventory form to the Division of Radiation Safety by the third Friday of the first month of the quarter.
6. See an example of a completed form on the next page. The form will be sent to you, filled out by DRS as our records indicate your activity received, waste picked up, etc.

If you have any questions concerning these instructions or the form, call DRS at 5289.

# EXAMPLE

RadSafe 11b

## QUARTERLY INVENTORY FORM

A.U. Name: John Jones

Radioactive Materials Quarterly Inventory Printed: 7/1/95

Radio-nuclide	Compound	Vendor	Date Rec'd	mCi Rec'd	On hand mCi	In lab waste mCi	$\Sigma$ mCi to CBARS
H-3	Thymidine	Amersha	7/1/90	5	2.5	1	1.5
P-32	dATP	NEN	6/2/95	0.25	0.1	0.15	---
P-32	dATP	NEN	6/16/95	0.25	0.1	0.15	---
S-35	CTP	NEN	6/30/95	0.25	0.15	0.1	---

TOTAL INVENTORY:

H-3 2.639 mCi P-32 0.188 mCi S-35 0.250 mCi

Notes:

Waste Transfers during quarter:

DATE Radionuclide Amounts (indicate if transfer activity is decay corrected)

6/1/95 H-3 0.012 mCi (lg barrel--dry trash)

DATE \_\_\_\_\_ SIGNED \_\_\_\_\_

RadSafe 13

UNIVERSITY OF MISSOURI-KANSAS CITY  
RADIOACTIVE WASTE PICK UP FORM

AU: \_\_\_\_\_

Permit No. \_\_\_\_\_

Department: \_\_\_\_\_

Bldg & Room No. \_\_\_\_\_

\_\_\_\_\_  
Signature of person authorizing pickup

Date Declared Waste \_\_\_\_\_

Container Type						
Isotope						
$\mu$ Ci						
Dose Rate @ Surface						
Dose Rate @ 1 Meter						
Wipe Test Results						
Disposal Date						
Disposal Mode						
Disposal by						
Mixed Waste (Y or N)						
Characteristic						

Hazardous Chemicals Present (include chemical names and % by weight (kg) or volume (L)): \_\_\_\_\_

Comments: \_\_\_\_\_

Picked up by \_\_\_\_\_

Date \_\_\_\_\_

**GENERAL GUIDELINES:**

1. Know the hazards of the materials you use. This includes not only radioactive, but chemical hazards. Determine if your radioactive waste also includes hazardous chemicals that need to be inventoried and disposed of as hazardous according to UMKC's Chemical Management Plan.
2. Obtain approved radioactive waste containers. Drums for solid dry waste and scintillation vials are available from CBARS, Division of Radiation Safety (DRS). Liquid waste containers should be nonreactive plastic, and no larger than 1 gallon plastic bottles. These may be obtained from the Procurement Department.
3. Label your waste containers with the radioactive caution label and indicate the radionuclide(s) present in the waste containers. You must also place the accumulation start date on the container. List the chemical names of any hazardous chemicals present in the waste and their hazards. If a mixture is present, estimate the percentages by weight or volume.

**TO HAVE WASTE REMOVED FROM LAB:**

1. Complete a Radioactive Waste Pick Up Form following the instructions below, and submit it to DRS. Put no more than four containers on one pick up form. (Multiple sheets per pick up may be accepted, however. Check with DRS.)
2. If hazardous chemicals are present in your radioactive waste, be sure the Mixed Waste section of the form is completed. Send the form to DRS. DRS staff will obtain a Hazardous Chemical Waste Tag for you to affix to your mixed waste prior to pickup.
3. A staff member will call to make an appointment to verify the contents of the pick up form and the waste, and to remove the waste from your laboratory.

**AT TIME OF PICK UP:**

1. A DRS staff member will review your Radioactive Waste Pick Up Form at the time of pick up. Please have a knowledgeable radiation worker present for the pick up.

**INSTRUCTIONS FOR COMPLETING RADIOACTIVE WASTE PICK UP FORM**

*Note: A sample entry, ready for submission to DRS, is provided on the form. Sample non-hazardous and hazardous containers are indicated on the form.*

**TOP SECTION:**

1. AU. The individual approved by the UMKC Radiation Safety Committee to use radioactive materials. (This is usually the faculty member supervising the laboratory.)
2. Radioactive Materials Permit Number. Each AU is assigned a permit number. It can be found on the RadSafe 4 Form, Authorization for Possession and Use of Radiation Sources.
3. Department. The department/school that the AU is a member of, e.g., Chemistry, Pharmacy, etc.
4. Building and Room number. The building and room number in which the radioactive waste is located.

**TABLE:**

1. Complete the **top** portion of the table, describing the radioactive waste. **Use one column per waste container collected.** Please use the container abbreviations indicated below. (The abbreviations also appear in the upper left hand corner of the pick up form.)

**RAD WASTE PICK UP FORM INSTRUCTIONS**  
**PAGE TWO**

Container description abbreviations:

- LgV: scintillation vials in 28 gallon fiberboard drum
- gal.: gallon liquid container--plastic bottle
- LgT: solid, dry trash in 28 gallon fiberboard drum
- Misc.: describe container in comments section or on back of form
- SmV: scintillation vials in 14 gallon fiberboard drum
- SmT: solid, dry trash in 14 gallon fiberboard drum

Isotope: Standard abbreviations are accepted: e.g.  $^3\text{H}$ ,  $^{14}\text{C}$ ,  $^{57}\text{Co}$

$\mu\text{Ci}$ : Note total activity in the container in microcuries.

**Complete "Mixed Waste" section only if hazardous chemicals are also present in your radioactive waste.**

Indicate "Y" if hazardous chemicals are present in a container.

Indicate the waste characteristic(s) in the appropriate space in the column. Use the same abbreviations as are used on a regular Waste Pickup Form:

- To- Toxic: LD50 <500 mg/kg, LC50 <1000 ppm, or listed toxic
- Re- Reactive, explosive, shock sensitive, air or water reactive, sulfide or cyanide bearing waste
- Ig- Ignitable, flash point less than 140 F or 60 C, or an oxidizer.
- Co- Caustic or corrosive, list pH if known
- In- Infectious agent to humans

Record the chemical name(s) of the wastes present, and their % by weight (kg) or volume (L) on the lines provided below the table designated "Hazardous Chemicals Present". Use the reverse side of the pick up form if necessary to record a complete description of the waste. Include a brief description of what was the chemical's use or what process produced it.

**Container Abbrev:**

- LgV gal.
- LgT Misc. - describe
- SmV SmT

Pickup No. \_\_\_\_\_