Radiation Safety Manual

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University Of Missouri
RADIATION SAFETY MANUAL

PURPOSE

Welcome to the University of Missouri-Columbia's Radiation Safety Manual. The Radiation Safety Manual contains the Radiation Safety Program procedures that have been approved by the Radiation Safety Committee to meet our regulatory obligations.

This manual provides information on what the individual responsibilities are with respect to the Radiation Safety Program, what must be done to meet these responsibilities, and the associated procedures. The manual divides this information into the different types of individuals and their roles (assignments) within the program. These different roles are: Authorized Users; Radiation Workers; Administrators (responsible for Authorized Users); Students, Faculty and Staff having access to radioactive materials (Ancillary Personnel); the Radiation Safety Committee; and the Radiation Safety Officer and Staff themselves.

Note: The forms in this manual are informational only, as they are subject to change. All current forms are available on the EHS Webpage. http://ehs.missouri.edu/

If you have any questions or suggestions for improvement, please contact us at 573-882-7018 or mail your comments to RS Office, 8 RPDB.

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ABBREVIATIONS

ALARA - As Low As Reasonably Achievable

AU - Authorized User

Bq - Becquerel

CDE - Committed Dose Equivalent

CEDE - Committed Effective Dose Equivalent

CFR - Code of Federal Regulations

Ci - Curie

cpm - Counts per minute

DDE - Deep-Dose Equivalent

DOT - Department of Transportation

dpm - Disintegrations per minute

dps - Disintegrations per second

EDE - Effective Dose Equivalent

EHS - Environmental Health and Safety

eV - Electron volt

GM - Geiger Mueller

Gy - Gray

HP - Health Physicist

H_E - Effective Dose Equivalent

$H_{E, 50}$ - Committed Effective Dose Equivalent

HMM - Hazardous Materials Management

H_T - Dose equivalent to organ or tissue

$H_{T, 50}$ - Committed Dose Equivalent

LDE - Lens of the eye Dose Equivalent

MBq - Megabecquerel

µCi - MicroCurie

mCi - MilliCurie

MQ - Medical Use Quorum

mR - Milliroentgen

mrem - Millirem

NRC - Nuclear Regulatory Commission

PBE - Performance Based Evaluation

Q - Quality factor

R - Roentgen

RCRA - Resource Conservation and Recovery Act

REM – Roentgen Equivalent Man

RSC - Radiation Safety Committee

RSCR - Radiation Safety Committee Representative

RSM - Radiation Safety Manual

RSO - Radiation Safety Officer

RSP - Radiation Safety Program

RS Office - Radiation Safety Office

RSS - Radiation Safety Staff

RU - Registered User

RW - Radiation Worker

SDE - Shallow-Dose Equivalent

SI – International System of Units

SNM - Special Nuclear Material

SQ - RSC Special Quorum

Sv - Sievert

$T_{1/2}$ - Half life

TEDE - Total Effective Dose Equivalent

MU - University of Missouri

w_T - Weighting factor

GLOSSARY

Absorbed Dose - The amount of ionizing radiation energy absorbed in matter, including human tissue. The units of absorbed dose are the Rad (R) and the Gray (Gy).

Access - The privilege to enter or use a restricted area without the presence of other Authorized Personnel.

Activity - The rate of transformation or disintegration or decay of radioactive material. The units of activity are disintegrations per minute (dpm), Curie (Ci), or Becquerel (Bq).

Administrator(s) Responsible for AU - Individual who directly supervises the AU's use of facilities plus the Administrative organization above leading to the Chancellor.

Air Sampling Survey - A measurement of radioactive material dispersed in air in the form of dusts, fume, particulates, mists, vapors, or gases. Measurements are typically taken in an individual's breathing zone or at a stack release point.

ALARA (As Low As Reasonably Achievable) - Each individual makes every reasonable effort to maintain occupational and public exposure to radiation as low as practical.

ALARA Dose Levels - Levels of personnel dose above which require a review of radioactive material use and procedures to determine if doses may reasonably be reduced (see ALARA Statement for levels).

Alpha Particle - A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus that has a mass number of four and an electrostatic charge of positive two.

Ancillary Worker – A non radiation worker whose duties require them to work in or frequent radiation work areas and who have been trained, corresponding with their work responsibilities, in the basics of radiation safety awareness training, and have been granted access to restricted areas for the performance of their duties.

Animal Waste - Any related waste, resulting from animals that have been dosed with radioactive material, such as bedding, urine, feces, other fluids, tissue, or carcass. All waste from a dosed animal shall be handled as radioactive material until proven otherwise by the RSS.

Assigned Health Physicist (assigned HP) - Each AU is assigned a HP who acts as the primary point of contact with the RS Office, and who is the primary radiation safety evaluator for the authorization.

Atom - The smallest particle of an element that cannot be divided or broken up by chemical means. It consists of a central core called the nucleus, which contains protons and neutrons. Electrons revolve in orbits in the region surrounding the nucleus.

Atomic Number - The number of protons in the nucleus of an atom. The number of protons determines what an atom is chemically, and, hence, identifies it as belonging to a certain chemical element.

Atomic Mass Number - The number of protons plus neutrons in the nucleus of an atom. Also known as the atomic weight of an atom.

Attenuation - The process by which a beam of radiation is reduced in intensity when passing through some material. It is the combination of absorption and scattering processes and leads to a decrease in intensity of the beam.

Audit - A thorough examination of an entire program. An audit may include a survey and an inspection.

Authorization - The privilege to receive, possess, use, and transfer radioactive material under MU's NRC License, or under a Missouri State Registration.

Authorization Application - Information provided by the prospective AU to the RSC in support of receiving the privilege of authorization. Information must include: personal data; isotopes, form, and amounts requested; type of use; special radiation safety procedures required; waste generation; restricted area(s), modifications, and facilities; instrumentation; training; experience; and administration support.

Authorization Specific Procedures - Radiation safety procedures established for the authorization. At a minimum, the authorization must adopt MU's RSP procedures, but these procedures may be modified with approval of the RSC.

Authorized Personnel - Personnel who have been trained, corresponding with their duties, in the basics of radiation safety and have been granted access to restricted area(s), e.g., AU's, RW's, and Ancillary Workers.

Authorized User (AU) - Individuals who are granted the privilege and responsibilities of receiving, possessing, using, and transferring radioactive material. The AU is also considered to be a RW.

Background Radiation - Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices.

Becquerel (Bq) - The SI unit of measurement of radioactivity equal to one disintegration per second. One Becquerel is equal to 2.7×10^{-11} Ci.

Beta Particle - A negatively charged particle that is emitted by certain radioactive atoms. A beta particle is identical to an electron.

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

"Biodegradable" or "Environmentally Friendly" Scintillation Cocktail - A liquid scintillation fluid that has a flash point greater than 300 °F or 150 °C.

Bremsstrahlung Radiation - Secondary electromagnetic radiation (x-rays) produced by deceleration of charged particles through matter.

Byproduct Material - Any radioactive material (except special nuclear material) made radioactive within or by the use of a nuclear reactor or special nuclear material.

Calibration – To adjust the reading of an instrument within acceptable tolerances using a known standard as a reference.

Calibration Check - Comparison of instrument readings relative to a radioactive material standard to confirm proper operation of the instrument or to determine counting efficiency.

Co-Authorization - An authorization approved for more than one AU. One AU must be designated as the "Primary" AU, who is the AU of record for receipt, use disposal, inspections and all other authorization records. The "Primary" AU is also the principal contact for the authorization. All other Co-AU's are designated as "Secondary" AU's.

Collective Dose - The sum of the individual doses received in a given period of time by a specified population from exposure to a specified radiation procedure or source of radiation. The usual units of collective dose are person-rem or person-sievert.

Committed Dose Equivalent (CDE or $H_{T,\,50}$) - The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. The units of the committed dose equivalent are the REM and the sievert (Sv).

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

Compliance - To act in accordance with and meet the responsibilities of regulatory requirements and MU's Radiation Safety Program procedures.

Contamination - Radioactive material present in places where it is undesirable and particularly in any location where its presence may be harmful.

Contained Form - Radioactive material that is confined such that the material is not readily available to be spread as contamination. This includes liquid radioactive material which is accessed via a needle through a septum vial (material removed from the septum vial via a syringe and not immediately transferred into another septum vial is considered to be uncontained).

Controlled Area - An area, outside of a restricted area but inside the MU campus *(site boundary)*, to which access can be limited by MU for any reason.

All MU property is considered to be within a controlled area.

Corrective Action - Actions taken to correct a situation of non-compliance or a situation which could lead to non-compliance.

Counting Instrument - A radiation detection instrument used to analyze swipes or other types of samples. Typical counting instruments are liquid scintillation, beta, or gamma counters.

Curie (Ci) - The basic unit of activity. A quantity of any radionuclide that undergoes an average decay rate of 37 billion disintegrations per second. One curie is the approximate activity of 1 gram of radium. Named for Marie and Pierre Curie, who discovered radium in 1898.

Declared Pregnant Woman - A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Decontamination - Removal of contamination.

Deep-Dose Equivalent (DDE) - As defined by the NRC, the dose equivalent estimated for a tissue depth of 1 cm. The deep-dose equivalent applies to external whole-body exposure and is intended to represent the upper limit to the dose received by the major organs and tissues of the body other than the skin and lens of the eye.

Deficiency Level - When a situation of non-compliance is identified, a deficiency level is assigned to define the required extent and timing for corrective actions.

Department of Transportation (DOT) - U.S. Federal department responsible for establishment of regulations relating to the transportation of radioactive and other hazardous materials.

Direct Supervision - Supervision within direct line of sight and communication provided by an AU or RW to individual(s) handling radioactive materials. The supervisor is responsible to see that all radiation safety procedures are followed.

Document - Printed or written evidence supporting compliance with regulatory requirements, MU's Radiation Safety Program procedures, and authorization specific procedures. The following must be documented: authorization; training; RW's; periodic surveys; radioactive materials inventory including receipt, transfer, waste disposal, and periodic decay corrections; and instrument calibrations.

Documented Survey - A survey which is performed and recorded to meet regulatory or policy requirements.

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

Dose Equivalent - The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the REM and the sievert (Sv).

Dose Limits - The limits of personnel dose set by the NRC which cannot be exceeded in a calendar year.

Dose Rate - In radiation safety, a measurement of radiation absorbed by various parts of the human body over a period of time. Dose rate must be documented in millirem per hour (mrem/hr).

Dosimetry (Personnel) - A radiation measuring devices worn by personnel to measure dose to various parts of the body.

Effective Dose Equivalent (EDE or H_E) - The sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (W_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma W_T H_T$).

Efficiency - For radiation detecting equipment, it is the ratio of radiation detected to radiation emitted and is specific for each isotope and geometry.

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

Electron - A subatomic particle with a negative charge. The electron circles the nucleus of an atom.

Electron Volt (eV) - Customary unit for expressing the energy of ionizing radiation. One eV is equal to the energy of one electron moving through a potential difference of one volt.

Element - One of the 118 known chemical substances that cannot be broken down further without changing its chemical properties.

Embryo/Fetus - The developing human organism from conception until the time of birth. More accurately; first 2 weeks-embryo (when implantation occurs), after 8 weeks- fetus.

Emergency - A sudden, generally unexpected occurrence or set of circumstances demanding immediate action.

Emergency Procedures - Procedures established to define the types of immediate actions to take in case of emergency to regain control of radioactive materials and prevent any additional spread of contamination.

Environmental Health and Safety (EHS) - MU department which includes the RS Office and is additionally responsible for establishing compliance criteria and monitoring for Environmental Management Section, Material Management, Industrial Hygiene, and General Safety.

Exempt Quantity - A quantity of radioactive material not requiring a specific or general license for possession and use, such as smoke detectors and small sources of radioactivity as those used in liquid scintillation counters or as check sources for instrument function tests. Exempt quantities are exempt for licensure but not from regulatory compliance.

Extremity Dose - Absorbed dose to hand, elbow, and arm below the elbow, foot, knee, or leg below the knee.

Eye Dose Equivalent (LDE) - Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.

Fixed Contamination - Contamination, generally on a surface, which cannot be removed by usual decontamination cleaning methods.

Formal Training - Classroom type training conducted by a radiation safety training program or a college credit course on radiation related topics. Documentation is needed for radiation safety training received from a program other than the MU's Radiation Safety Training Program or for college credit courses.

Fume Hood - A hood designed to exhaust fumes or particulates away from the individual and out of the building.

Gamma Radiation or Gamma Ray - High-energy, short-wavelength electromagnetic radiation emitted from the nucleus. A gamma ray is a discrete packet of electromagnetic energy. Gamma radiation frequently accompanies alpha and beta emissions. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are identical to x-rays, but have a nuclear origin, rather than an atomic origin.

Gray (Gy) - The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 J/kg or 100 rad.

Half Life ($T_{1/2}$) - The time taken for the activity of a radionuclide to lose half its activity value by radioactive decay.

Hazardous Materials - A substance or material, including a hazardous substance, which by quantity, concentration, physical, and or chemical characteristics has the potential of becoming hazardous waste or regulated by RCRA (Resource Conservation and Recovery Act).

Hazardous Waste - A hazardous waste as defined in 40 CFR 261.3 and applicable State regulations.

High Energy Beta - A beta emitted with maximum energy greater than 1 MeV.

High Radiation Area - An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Imminent Danger to Health and Safety - Although reaching dose limits results in a minimal health risk, "Imminent Danger to Health and Safety" means any circumstance or set of circumstances that could result in dose limits being exceeded.

Inactive Status - An inactive AU remains authorized but either has no radioactive material at all, or the radioactive material is secured, such as in a locked cabinet or refrigerator/freezer. Other than the storage unit, the authorization is closed out. To reactivate the

authorization, the AU must, along with their assigned HP, conduct a review of the authorization, review any changes in MU's RSP procedures, and reactivate approved radioactive material use areas. The authorization must be reactivated prior to receipt of radioactive material.

Incident - An occurrence that either results in an item of non-compliance or could have led to an item of non-compliance if the occurrence had not been identified.

Informal Training - On-the-job-type training; typically on authorization-specific procedures.

Inspection - An examination of procedures, records, safety issues, and personnel performance, including comparison of AU and RS Office data and records. An inspection generally includes a survey and is typically conducted by EHS or the NRC.

Inspection or Survey Class - Level of radiation safety inspection frequency designated for the authorization. Class I is monthly, Class II is quarterly, Class III is semi-annually, Class IV is for sealed source only authorization, Class V is inactive status, and Class VI is Co-Authorization Secondary AU.

Intake - Quantity of material entering the body, the principal routes being by inhalation, by ingestion, or through intact or wounded skin.

Interim Authorization - Authorization issued by the RSO prior to final review and approval of the authorization applications by the RSC.

Internal Contamination - Contamination which is on internal components of equipment.

Internal Dose - Dose received from radioactive material which is taken into the body. See Dose and External Dose.

Inventory - A documented list recording the receipt, use, transfer, decay and disposal of radioactive material so that the amount, location and disposition of the radioactive material received under the authorization may be determined at any point in time.

Isotope - One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13 and carbon-14 are isotopes of the element carbon, the numbers denoting the atomic mass number. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

Labeled Equipment, Apparatus, or Appliances - Centrifuges, refrigerators, hoods, vials or other equipment that contains radioactive material or is contaminated must be labeled with the appropriate radioactive material label. Equipment, such as centrifuges and water baths' that can be internally contaminated, must be labeled with the appropriate radioactive material label and a warning of contamination inside the unit. Lab personnel must be cognizant of the contamination and prevention methods to be avoid spread of contamination. Affixing appropriate radioactive/radiation labels to equipment, doors and storage units (refrigerator, freezer) to demarcate restricted areas..

Laboratory Apparel - The type of clothing and other protective gear worn by individuals when working in and around radioactive materials.

Leak Test - A check of sealed source integrity by physically wiping a specified area with a cotton swab or other medium. The test is then counted for the presence of radioactive material in an appropriate detection system. The detection system must be able to detect 5 nCi of activity. Any level greater than that indicates the source is leaking and must be removed from service, secured and the NRC notified of the breach.

License - The document issued by the NRC permitting MU to receive, possess, utilize, transfer, or dispose of specific byproduct, source, or special nuclear materials. Currently MU is licensed under Broad Scope License No. 24-00513-32.

License Condition - A requirement established specific to MU licenses which can only be changed through a license amendment issued by the NRC. Failure to meet a license condition, like failure to meet Federal Regulations, will most likely result in an NRC violation, possible civil penalty (monetary fine), and possible criminal prosecution.

Liquid Waste - Radioactive waste in liquid form. This waste may be unwanted radioactive stock solutions, liquid waste from radioactive procedures, or used liquid scintillation cocktail.

Low Energy Beta - A beta emitted with maximum energy less than or equal to 300 keV.

Medical Use Quorum (MQ) - A specific subset of the RSC established by the license condition to oversee the medical use of radioactive materials.

Medium Energy Beta - A beta emitted with maximum energy greater than 300 keV and less than or equal to 1 MeV.

Member of the Public - Any non-radiation worker. These individuals may not be exposed to any environment where there is the potential to exceed 2 mrem in any one hour or receive 100 mrem in one year.

Minor - An individual less than 18 years of age.

Mixed Waste - A radioactive waste that is also a hazardous waste. Mixed waste must be handled as both radioactive waste and hazardous waste.

Modified Restricted Area - A restricted area that has been modified, where part of the room remains a restricted area and part of the room is designated as a non-restricted area. The RSC must approve any modification of an existing restricted area.

Monitoring - An assessment of current radiological conditions performed during the work period. This includes the periodic checks for contamination or radiation levels on the hands, clothing, floor and immediate work area.

MU Radiation Safety Program - The program established by the MU Broad Scope License, administered by the RSC and MU Administration, and implemented by the RS Office.

MU Radiation Safety Program Procedures - General overall procedures established and monitored by the RS Office to meet compliance with regulatory requirements, license conditions and policies established by the Radiation Safety Committee.

Must - Same as **Shall**.

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

Non-Stochastic Effects (or Deterministic Effects) - Health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation induced cataract formation is an example of a non-stochastic effect.

Nuclear Regulatory Commission (NRC) - The government agency responsible for establishing regulations and issuing licenses for byproduct, source, or special nuclear material.

Occupational Dose - Dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 10 CFR 35.75, from voluntary participation in medical research programs, or as a member of the public.

Open Bench Quantities - The amount of radioactive material which may be handled in uncontained form on an open bench. Quantities greater than this must be kept contained, handled only in a fume hood or glove box, or a specific evaluation of the chemical process done to show what specific activity limit assures little likelihood for airborne activity.

Packaging - The assembly of components necessary to ensure compliance with the packaging requirements of NRC and DOT. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and/or devices for cooling or absorbing mechanical shock.

Performance-Based Evaluation - Observation of an individual's ability to properly execute and accomplish the necessary actions basic to the completion of a task; thus demonstrating the adequacy of training, proper knowledge and ability to perform a procedure to assure regulatory compliance.

Performance-Based Training - Training of an individual in the "hands on" aspects of procedures, by practicing and perfecting under supervision the necessary actions basic to the completion of a task.

Personnel Monitoring - Measurement of personnel dose through the use of personnel dosimetry, air samples, bioassays, radiation surveys or any combination of the above with related calculations.

Personnel Protective Equipment (PPE) - Equipment designed to maximize the control of radioactive material or to minimize dose or contamination. This includes but is not limited to safety glasses, lab coats, gloves, fume hoods, shields, security cabinets or areas, spill trays, etc.

Photon - A quantum (or packet) of energy emitted in the form of electromagnetic radiation. Gamma rays and x-rays are examples of photons.

Positron - Particle equal in mass, but opposite in charge, to the electron; a positive electron.

Posting - The conspicuous placing of signs, notices, announcements, procedures, etc. in and around restricted areas that inform individuals of the types of precautions they must take.

Proton - An elementary nuclear particle with a positive electric charge located in the nucleus of an atom.

Prudent Practice - The attitude towards dealing with hazards in the laboratory characterized by a determination to make every effort to be informed about risks and reduce them to a minimum. This "safety first" attitude is accomplished through an increased emphasis on experiment planning, including habitual attention to risk assessment and consideration of hazards for oneself, one's fellow workers, and the public.

Public Dose - Dose received by a member of the public from exposure to radiation or radioactive material released by the licensee, or to any other source of radiation under the control of a licensee. Public dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 10 CFR 35.75, from the voluntary participation in medical research programs, or as a member of the public.

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

Rad - The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/g or 0.01 J/kg or 0.01 gray. This unit applies to any type of ionizing radiation absorbed in any material. If material is not specifically stated, then tissue is assumed.

Radiation - In this manual, radiation refers to ionizing radiation, such as x-ray, gamma, alpha, beta and neutron.

Radiation Area - An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

Radiation Levels - Measurement of dose or dose rates.

Radiation Safety Committee (RSC) - The group established by regulation and license condition responsible for overseeing the MU RSP and controlling the use of radioactive materials under the MU license.

Radiation Safety Committee Representative (RSCR) - A member of the RSC who is an AU, or has the training and experience to become an AU, and is assigned a group of AU's to represent.

Radiation Safety Manual (RSM) - This document describes the MU Radiation Safety Program responsibilities, duties, and procedures which need to be understood and followed by the RSS, Ancillary Workers, RW's, AU's or Administrators Responsible for AU's.

Radiation Safety Office (RS Office) - The group responsible for assisting the RSO in the implementation of the MU Radiation Safety Program. This group is part of and is assisted by EHS, a unit of Business Services.

Radiation Safety Officer (RSO) - As required by regulations, this individual is responsible for the implementation of the MU RSP. This individual ensures that radiation safety activities are being performed in accordance with RSC policy, approved procedures, and regulatory requirements in the daily operation of the MU RSP.

Radiation Safety Program (RSP) – MU's RSP is a commitment to the following criteria; Applicants for Type A, Type B, and Type C broad scope licenses are required by 10 CFR 33.13(c), 33.14(b), and 33.15(c) respectively, to establish administrative controls and provisions relating to management review necessary to ensure safe operations. Licensees are required by 10 CFR 20.2102 to maintain records of the radiation protection program, including: (1) the provisions of the program; and (2) audits and other reviews of the program contents and implementation.

Radiation Safety Staff (RSS) - Individuals assigned to the RS Office to assist in the implementation of the MU RSP. This includes but not limited to the RSO, Deputy RSO, HP's, and EHT's.

Radiation Worker (RW) - Individual trained in radiation safety that is approved to work, under the authorization of an AU with radioactive material without direct supervision. The AU is responsible for each RW, and their acts of commission or omission who are approved to work under the authorization. A RW may work under more than one authorization at a time, but must be approved by each AU.

Radioactive Materials - Materials that decay by emitting ionizing radiation. For MU these are radioactive materials approved in the MU license and radioactive materials registered with the State of Missouri.

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

Radioisotope Work Area - An area (within a restricted area) designated specifically for working with radioactive materials, where the appropriate protective measures have been taken to minimize excessive radiation levels or the spread of radioactive contamination outside the work area.

RCRA - Resource Conservation and Recovery Act of 1976 as amended.

Recovery Operation - Procedures established following the completion of emergency procedures, which are designed to return the areas, facilities, and personnel contamination levels back to normal operating conditions.

Reference Man - A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Registered User - Individual who holds the primary authority to direct the activities of a laboratory or facility that may at any time use or store hazardous materials or generate potentially hazardous waste (including radioactive mixed waste).

Regulations - Rules and requirements established by regulatory agencies.

Regulatory Agencies - The regulatory agencies which directly impact the MU Radiation Safety Program including the Nuclear Regulatory Commission (NRC), Department of Transportation (DOT), Environmental Protection Agency (EPA), Missouri Department of Health and Senior Services (MO DHSS), Missouri Department of Natural Resources (MO DNR), and the City of Columbia.

Rem - The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in REM is equal to the absorbed dose in rad multiplied by the quality factor. One REM equals 0.01 sievert.

Removable Contamination - Contamination which can be removed or spread by something coming in contact with the contaminated surface.

Restricted Area - Any area to which access is restricted for the purpose of radiological protection. At MU, the restricted area shall include the entire laboratory area (including rooms to which access can only be made through the laboratory) bound by walls and a lockable door, unless a restricted area modification is granted.

Review - A radiation safety examination of an AU or prospective AU to assess their ability to begin or continue working with radioactive materials.

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

Sealed Source - Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions likely to be encountered in normal use and handling. Sealed sources are registered by the manufacturer through the NRC.

Security - Protection of radioactive material from unauthorized removal or access.

Self-Assessment - Continual critical evaluation of personnel, procedures, facilities, and areas to identify incidents or weaknesses which could lead to non-

compliance. This evaluation includes doing root cause analysis, establishing corrective action, providing additional training or awareness as necessary, and reassessing resulting compliance.

Shall - Denotes a requirement.

Shallow-Dose Equivalent (SDE) - Applies to the external exposure of the skin or an extremity, and is taken as the dose equivalent at a tissue depth of 0.007 cm averaged over an area of 1 cm^2.

Should - Denotes a recommendation.

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

Site Boundary - That line beyond which the land or property is not owned, leased or otherwise controlled by the licensee.

SI Units - Units defined by the International System of Units.

Solid Waste - Primarily paper, plastic, glass, or gloves which are potentially contaminated with radioactive material.

Source Material - Means: (1) Uranium or Thorium or any combination of Uranium and Thorium in any physical or chemical form; or (2) Ores that contain, by weight, 0.05 percent or more, of Uranium, Thorium or any combination of each. Source material does not include special nuclear material.

Special Nuclear Material - Means Plutonium, Uranium-233, enriched Uranium in the isotope 233 or the isotope 235, or any other material that the NRC determines to be special nuclear material, but does not include source material.

Special Quorum (SQ) - A subset of the Radiation Safety Committee, generally established to review and approve authorized use of radioactive materials and to administer radiation safety as it applies to various specialized fields.

Specific License - A license issued by the United States Nuclear Regulatory Commission (NRC) to possess and use radioactive materials. For MU, this constitutes the Broad scope License, administered by the Radiation Safety Committee (RSC) and the Radiation Safety Staff. This license is considered to be an "umbrella" over all General Licensed quantities as well as radioactive materials needing a specific license for possession. See Exempt Quantities

Stock - Radioactive material remaining in the container originally supplied by the vendor.

Stochastic Effects - Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Surface Contamination Survey - Radiation level readings taken at one cm from the surface with open detector window.

Survey - An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Survey Meter - Radiation detecting instrument capable of detecting dose rates, and most surface contamination.

Temporary Transfer of Authorization - When an AU will be gone for more than 30 days at one time, the authorization must be temporarily transferred to another approved AU.

Termination of Authorization - Means that no radioactive materials are possessed (including any contaminated supplies or equipment). All approved areas are closed out and all RW approvals under the authorization are terminated.

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

Transfer - Change in possession of any radioactive material from one authorization to another or from an authorization to another licensee.

Transient Radioactive Work Area - The area where radioactive materials are used for infrequent short periods of time (generally <8 hours), where constant line-of-sight control and/or lockable security is

maintained, and where the area will have a documented survey confirming that no radioactive material remains in quantities greater than those allowed for unrestricted areas, at the conclusion of the use. These transient work areas do not require posting.

Transportation - For MU, transportation means movement of any radioactive material by means of a person, or a commercial or university vehicle.

Unauthorized personnel - Any personnel or visitor who is not trained for access to restricted areas.

Uncontained Form - Radioactive material in an open form, capable of spreading contamination; particularly if overturned.

Unrestricted Area – Any area where access is not controlled for radiation protection. (See Controlled Areas)

Use - Physical manipulation of radioactive material in the uncontained form.

Weighting Factor (W_T) - A factor that indicates the ratio of the risk of stochastic effects attributable to irradiation of a given organ or tissue (T) to the total risk when the whole body is uniformly irradiated.

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

INTRODUCTION

The University of Missouri (MU) Campus possesses a broad scope license issued by the U.S. Nuclear Regulatory Commission (NRC). The license allows MU to receive, possess, use, and transfer byproduct, source special nuclear material, accelerator-produced radioactive materials and some naturally occurring radioactive materials. The license covers much of the radioactive material work conducted at the MU. The State of Missouri regulates x-ray machines and accelerators and will cease regulation of accelerator-produced radioactive materials during 2008. The State administers their program in a similar manner to the NRC-

WHAT IS A BROAD SCOPE LICENSE

MU's NRC license (No. 24-00513-32) is a Type A, Broad Scope license. A broad scope license allows an organization involved in an extensive radioactive materials program to internally regulate its own program, within the requirements established by the regulations and license commitments. To obtain a broad scope license, MU established an overall Radiation Safety Program (RSP) by defining the organization and management, procedures, record keeping, radioactive material control, accounting and management review necessary to assure safe use of radioactive material at MU.

The use of byproduct materials authorized by the MU license is controlled by the Radiation Safety Committee (RSC), and is administered by the Radiation Safety Officer (RSO), and the Radiation Safety Staff (RSS). The RSC may authorize individuals to use byproduct material in accordance with established review and approval procedures and criteria established by the RSC.

WHAT MUST THE RSC AND RSO DO?

The MU RSC is generally composed of the RSO, a representative of management, and persons trained and experienced in the safe use of radioactive materials. The RSC includes a Medical Quorum (MQ) designed to meet the regulatory requirements of MU medical use portion of the license. The RSO must be qualified by having training and experience in radiation protection, and be available for advice and assistance on radiological safety matters.

The RSC is required by regulations and license conditions to establish policy and general procedures to

- Control procurement and the use of byproduct material,
- Evaluate safety concerns related to the use of byproduct material prior to use, by reviewing the adequacy of (a) facilities and equipment, (b) training and experience of the user, and (c) lab-specific operating and handling procedures.

The RSO and RSS are responsible for establishing and maintaining specific procedures to carry out the policies and procedures established by the RSC.

WHAT MU IS NOT ALLOWED TO DO UNDER ITS BROAD SCOPE LICENSE

Certain activities are not permitted under a broad scope license. MU is not authorized to

- Conduct tracer studies in the environment involving the direct release of radioactive material;
- Receive, acquire, own, possess, use, transfer or import sealed devices containing 100,000 curies or more of byproduct material;
- Conduct activities to manufacture or transfer certain items containing byproduct material, or perform industrial radiography operations;
- Add or cause the addition of byproduct material to any food or other product designated for ingestion or inhalation by, or application to, a human being, except as approved under medical use portion of the license.

ALARA STATEMENT

MU is committed to the ALARA philosophy and therefore sets forth the following ALARA policy

ALARA is the acronym for "As Low As Reasonably Achievable." The ALARA philosophy applied to radiation safety programs is to maintain minimal levels of occupational radiation exposures and releases of radioactive effluents to the environment. The ALARA concepts are extensions of the radiation protection guides in that any unnecessary radiation exposures are considered excessive. The Radiation Safety Program at the University of Missouri is committed to the ALARA principles for reasonably reducing radiation exposures.

The ALARA principle is practiced throughout the Radiation Safety Program. Radiation Safety Program reviews and audits are conducted by the Radiation Safety Committee. All requests for use of radioactive materials are considered by the Radiation Safety Staff, and the Radiation Safety Committee to insure that operations are conducted in an efficient manner by properly trained personnel. Continued radiation safety surveillance and inspection by the Radiation Safety Program insures that proper procedures are being used. Records of the inspections, surveys and personnel dosimetry are maintained and compared to evaluate the success of ALARA program. Action levels are established at values well below the allowable dose limits and investigations are conducted when the action levels are exceeded. Radiation users must contribute to the ALARA programs by providing continuous reviews and improvements of their radiation protection procedures.

The ALARA program is the responsibility of all persons involved in the use of radiation at the University of Missouri. Administrators, faculty, staff, Radiation Safety Staff, and radiation users, participate and cooperate in the development and improvement of the ALARA concepts as applied to the Radiation Safety Program.

The management of the University of Missouri is committed to maintaining its radiation safety program for materials licenses consistent with the ALARA philosophy.

All individuals who have radiation safety responsibilities of any nature for a material license (e.g., administrative, operational, procedural, and/or ancillary responsibilities) will be instructed in the ALARA Policy.

The Radiation Safety Committee will review quarterly ALARA reports prepared by the Radiation Safety Officer. Appropriate actions will be taken on external and internal radiation doses that exceed the investigational levels listed in the “ALARA INVESTIGATION LEVELS” table.

Radiation dose investigational levels and reporting frequencies different than those listed may be established by the Radiation Safety Officer for an individual worker or a group of workers. Justification for new action levels will be documented and must be consistent with good ALARA practices. The Radiation Safety Committee will review the justification for and must approve or disapprove all revisions to the investigational levels.

ALARA Investigation Levels						
Exposure Type	**Quarterly** (mrem)			**Monthly** (mrem)		
	Level I	**Level II**	**Special***	**Level I**	**Level II**	**Special***
Total **E**ffective **D**ose **E**quivalent: (**TEDE)**	125	375	600	100	300	300
Lens **D**ose **E**quivalent (**LDE**)	375	1250	600	300	900	300
Shallow **D**ose **E**quivalent (**SDE**)	1250	3750	6000	400	1200	3000
Committed **E**ffective **D**ose **E**quivalent (**CEDE**)	1250	3750	6000	400	1200	3000

Definitions

Total **E**ffective **D**ose **E**quivalent: (**TEDE)**
Sum of both **D**eep **D**ose **E**quivalent and **C**ommitted **E**ffective **D**ose
TEDE = **DDE** + **CEDE**

Deep **D**ose **E**quivalent: (**DDE**)******
External whole body exposure at a tissue depth of 1 cm

Lens **D**ose **E**quivalent: (**LDE**)
External exposure to the lens of the eye at a tissue depth of 0.3 cm

Shallow **D**ose **E**quivalent: (**SDE**)
External Exposure at a tissue depth of 0.007 cm or to any extremity.

Shallow **D**ose **E**quivalent **M**aximum **E**xtremity: (**SDE_ME**)
External Exposure at a tissue depth of 0.007 cm, maximum to any extremity

Committed **E**ffective **D**ose **E**quivalent: (**CEDE**)
Exposure to organs or tissue that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Notes

***** The MU Radiation Safety Committee may establish different investigational levels or reporting frequencies for an individual worker or group of workers.

** Webster calculation may be used to account for DDE doses when wearing a lead apron.

AUTHORIZED USER

RESPONSIBILITIES

TRAINING

The Authorized User shall:

Communicate to colleagues, staff, students and visitors that the health, safety, and concern for a safe workplace are top priorities at MU. Everyone shares the obligation to perform work in a safe, healthful, environmentally protective manner.

Ensure that radiation safety policies and procedures are communicated to employees, students and visitors appropriate for their situation.

Ensure that individuals handling radioactive materials are trained in and understand the proper authorization-specific radiation safety procedures. The AU is responsible for the actions of all workers who handle radioactive materials under the specific authorization.

MATERIAL CONTROL

The Authorized User shall:

Ensure every individual's exposure from radioactive materials and radiation is ALARA.

Establish and implement authorization-specific procedures to be in compliance with MU RSP procedures.

Ensure that authorization-specific procedures are in place and observed.

Ensure that individuals working under the authorization have the proper safety equipment and laboratory apparel to perform their work safely.

ASSESSMENT/CORRECTION

The Authorized User shall:

Ensure that radiation safety responsibilities are being carried out by all individuals working under the authorization.

Encourage an atmosphere where there is the prompt reporting of health and safety concerns.

Curtail or stop work that is being carried out under the authorization if continuation of the work is believed to pose an imminent danger to health or safety. Immediately notify the RSS when work is curtailed or stopped for this reason.

Establish, review, implement, and document completion of acceptable corrective actions to prevent reoccurrence of this radiological event.

WHAT MUST BE DONE

TRAINING AND PERFORMANCE-BASED EVALUATIONS

Fulfill training requirements to become an Authorized User, and update training as required to maintain and renew authorization.

Review Authorization form and associated authorization applications with each RW and define RW's specific responsibilities under the authorization.

Determine by performance-based evaluations that RW's can properly perform the authorization-specific radiation safety procedures.

Register each individual who is allowed to work with radioactive material without direct supervision as a RW.

Ensure that work requiring training is performed only by persons who have received the proper training i.e. no one can work with radioactivity until they have trained.

Review the corrective actions with RW's as necessary.

Document all authorization-specific training and know where training records are kept.

MATERIAL CONTROL

Develop and periodically review the radiological work procedures to ensure that radiation hazards are controlled or eliminated. The AU may adopt the MU program procedures or adapt other procedures, while ensuring that the other procedures meet the intent of all the requirements of the authorization-specific procedures.

Verify the following information provided via the RS office's authorization specific quarterly report:

- Any new radioactive material receipts,
- any transfers,
- any waste pickups,
- any changes in RW status,
- any changes in sealed sources
- any changes in authorization specific instrumentation, and
- current on-hand inventory.

SELF ASSESSMENT AND CORRECTIVE ACTIONS

Perform periodic documented surveys to ensure that routine handling surveys performed by the RW's are effective.

Review the documented surveys to determine trends and any need for corrective actions (e.g., change in procedure, work area, equipment, personnel training, personnel accountability, shielding, ALARA techniques, etc.).

Review and follow up on inspections performed by the RSS or the NRC, and correct any authorization-specific procedures that led to any deficiencies or as necessary.

Interact with the assigned RSC Representative concerning any suggested changes or corrective actions needed in the specific authorization program or in the MU RSP.

PROCEDURES

HOW AND WHEN TO COMPLETE A AUTHORIZATION APPLICATION

HOW TO COMPLETE EACH PAGE OF THE APPLICATION

WHEN TO COMPLETE AUTHORIZATION APPLICATION

Use of radioactive materials on the MU Campus (other than at the MU Research Reactor) is allowed only under Authorizations approved by the MU RSC.

Control of the uses of radioactive materials is established by MU's NRC License, State Registrations, and by local, State and Federal regulations.

To establish an Authorization, an individual must submit an Authorization Application and in turn must be approved by the RSC to become an AU.

Once an Authorization is established, the AU must submit application amendments in order to make certain changes in the Authorization.

This procedure describes when an application is needed and what application pages are needed for specific changes.

An Authorization is issued for no more than a three year period. A renewal application is required to extend the Authorization. The Authorization is allowed to continue work if the renewal application has been accepted by the RS Office.

Contact your assigned Health Physicist if you have any questions.

APPLICATION TYPE AND THE REQUIRED PAGES

New User:

Application Initiation Page (indicating New User)
Authority Page
Training and Experience Page
Isotope Page
Anticipated Transactions Page
Radioactive Material Location Page (one for each room/area)
Radiation Survey Instrumentation Page

Isotope Added or Increased:

Application Initiation Page (indicating Amendment)
Authority Page
Isotope Page
Anticipated Transactions Page
Radiation Survey Instrumentation Page

Isotope Deleted or Decreased:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating Amendment for isotope deletion or decrease)

Room Removed or Inactivated:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating Amendment for room removal or inactivation)

Room Added, Location Changed, or Modified Restricted Area Requested:

Application Initiation Page (indicating Amendment)
Authority Page
Radioactive Material Location Page (one for each room/area) -- **NOTE**: Modification of existing restricted area requires a detailed explanation of the controls that will be implemented to separate the restricted area from the rest of the room

Renew Authorization:

Application Initiation Page (indicating Renewal)
Authority Page
Isotope Page

Establish Co-Authorization or add a Secondary User to the existing Co- Authorization Application:

Application Initiation Page (indicating Co-Authorization for each Secondary User)
Co-Authorization Authority Page
Training and Experience Page (for each Secondary User)
Isotope Page (for each Secondary User)

Inactivate Authorization:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating Inactivation)

Re-activate Authorization:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating Re-activation)

Temporary Transfer Authorization:

Application Initiation Page (indicating Temporary Transfer)
Temporary Transfer of Authorization Page

End of Temporary Transfer Authorization:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating end of Temporary Transfer)

Terminate Authorization:

Contact your assigned HP for an Administrative Change -- may use: Application Initiation Page (indicating Termination)

APPLICATION INITIATION PAGE

PURPOSE

An Application Initiation Page must be completed for all applications. All applications are tracked by Authorization Number and application date.

COMPLETING THE APPLICATION INITIATION PAGE

All applications are tracked by the Authorization Number and application date.

Complete the Authorization Number and application date at the top. For new user applicants, an Authorization Number will be assigned at application review.

Indicate the application type.

Complete the personal data (to update changes from previous application).

Sign the AU statement to confirm acceptance of responsibilities.

UNIVERSITY OF MISSOURI
APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

APPLICATION INITIATION PAGE

[This form or attachment must be typed or printed very neatly in black ink]

Application Type: [ ] New [ ] Amendment

[ ] Renewal [ ] Co-Authorization

[ ] Inactivation [ ] Reactivation

[ ] Temporary Transfer [ ] Termination

Personal Data

Name: ID#:

Degree(s): Job Title:

Department/Unit: Office Address:

E-Mail Address: Office Telephone:

Lab Telephone: FAX:

Authorized User Statement

I have read the Radiation Safety Manual and understand to the best of my knowledge its application to my requested use of radioactive material. I understand my responsibility as an Authorized User to train and provide a safe work environment for my personnel in accordance with University policy, State and Federal regulations. I understand my responsibility to maintain proper records by documenting radiation surveys and maintaining radioisotope inventory records. I accept the responsibilities of being an Authorized User and will comply with the MU Radiation Safety Program.

_____ _____
Applicant Signature Date

For Radiation Safety Office Use Only

_____ _____ _____ _____
Health Physicist Date Chair, Radiation Safety Committee Date

For New Authorizations for Human Use: _____ _____
MU Administrator Date

AUTHORITY PAGE

PURPOSE

All AU's must demonstrate administrative support for their authorization. The Administrator responsible for the AU is based on the primary location of the AU's authorized work. If the AU requests use of an area supervised by another administrator, then support for use of that area must also be obtained.

COMPLETING THE AUTHORITY PAGE

The AU is responsible for completing the information on this page.

The AU is responsible for obtaining the required signature(s) for this page.

Direct Supervisor -- NOTE: Signing of the Direct Supervisor Statement confirms acceptance by the Administrator of the responsibilities listed in Administrator Responsibilities.

Supervisor support for other areas -- NOTE: These sections must be completed when the AU applicant is requesting additional rooms in areas not supervised by the Direct Supervisor. Signing of the "Supervisor for Other Area" statement confirms acceptance by the administrator of the responsibilities listed in Administrator Responsibilities.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

AUTHORITY PAGE

Direct Supervisor Statement

Supervisor Name:

Supervisor Title:

Supervisor's Department/Unit/Other:

I support the use of radioactive materials by this Authorized User Applicant. I understand my responsibilities to the best of my knowledge as a supervisor of an Authorized User.

_____ _____
Direct Supervisor Signature Date

Supervisor for Other Area

Supervisor Name:

Supervisor Title:

Supervisor's Department/Unit/Other:

I support the use of radioactive materials by this Authorized User Applicant in the area(s) listed below. I understand my responsibilities to the best of my knowledge as a supervisor of the rooms being utilized by this Authorized User.

Building: Room(s):

Building: Room(s):

_____ _____
Supervisor for Other Area Signature Date

CO-AUTHORIZATION AUTHORITY PAGE

PURPOSE AND CONDITIONS

A Co-Authorization is considered as one authorization having one Primary User and one or more Secondary Users.

All inventories for a Co-Authorization are combined under the Primary User's Authorization isotope limits and conditions.

All Secondary AU's must have the support of the Primary User and the Primary User's Administrator to join in a Co-Authorization. The Primary User may request removal of the Secondary User from the Co-Authorization and document this request in writing with the RS Office.

A Secondary AU may be fully Co-Authorized for the entire Primary User's authorization or Co-Authorized for a defined portion of that authorization, however, a Secondary User must meet the criteria of being a Primary User for all of the Co-Authorization specifically approved for the Secondary User.

COMPLETING THE CO-AUTHORIZATION AUTHORITY PAGE

The Secondary User is responsible for completing the information on this page.

The Secondary User is also responsible for obtaining the required signature(s) for this page.

Signing of the Primary User and the Primary User's Direct Supervisor Statements confirms acceptance by the Primary User and the Administrator of the stated support.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

CO-AUTHORIZATION AUTHORITY PAGE

[This form or attachment must be typed or printed very neatly in black ink]

Co-Authorization Primary User Statement

Primary User Name: Authorization Number:

[ ] Full Co-Authorization [ ] Partial Co-Authorization (attach description)

I support the inclusion of this individual for Co-Authorization on the Authorization for which I am the Primary Authorized User.

_____ _____

Primary User Signature Date

Primary User's Direct Supervisor Statement

Supervisor Name:

Supervisor Title:

Supervisor's Department/Unit/Other:

I support the inclusion of this individual as indicated above. .

_____ _____

Primary User's Direct Supervisor Signature Date

TRAINING AND EXPERIENCE PAGE

PURPOSE

The RSC must review the training and experience of all individuals requesting authorization.

Criteria for acceptable training and experience are based on the proposed uses and amounts of radioactive materials.

REQUIREMENTS - GENERAL

Individuals requesting permission to direct studies utilizing uncontained radioactive materials exceeding the quantities listed in 10 CFR 20 Appendix C must meet the following criteria:

- A bachelor level college degree or equivalent of training and experience in physical or biological sciences,

- At least 20 classroom hours of training, or equivalent training and experience in the safe handling of radioactive materials, characteristics of limiting radiation exposure, units of radiation dose and quantities, radiation detection, instrumentation and biological hazards of exposure to radiation.

Refresher training is required periodically (see MU Radiation Safety Training Program).

REQUIREMENTS - SEALED SOURCES AND OTHER CONTAINED SOURCES

Individuals requesting permission to direct studies utilizing sealed sources, contained sources, foils, vendor prepared assay kits, or other uncontained radioactive materials less than the quantities listed in 10 CFR 20 Appendix C must meet the following criteria:

- An associate level degree or equivalent training and experience in technical, medical, physical, or biological areas,

- At least 8 hours of training and experience, including 4 hours of formal classroom/laboratory instruction with 4 hours of supervised experience, concerning the understanding of radiation units, radiation detection, regulations, emergency procedures and specific instruction appropriate to the type and form of byproduct materials to be used.

Refresher training is required periodically (see MU Radiation Safety Training Program).

REQUIREMENTS - MEDICAL

Individuals requesting permission for medical use authorizations must contact the RS Office for special instructions commensurate with the requirements of 10 CFR 35.

Refresher training is required periodically (see MU Radiation Safety Training Program).

COMPLETING THE TRAINING AND EXPERIENCE PAGE

Complete the personal data section. This is for the AU applicant only.

Document the type, date, and the duration of classroom (formal) training you have received on listed topics. Indicate where training was received. (At a minimum the applying AU must meet the training requirements listed above. If not, the AU will need to complete additional training).

Document the type, date, location and duration of experience you have working with radioactive materials.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

TRAINING AND EXPERIENCE PAGE

[*This form or attachment must be typed or printed very neatly in black ink*]

Personal data

Name: Date of Birth:
Sex: [ ] Female [ ] Male

Statement of Training (minimum of 20 total classroom hours or equivalent training and experience):

Provide the following information and documentation substantiating your training in: Principles and practices of radiation protection; Biological effects of radiation; Basic calculations for radioactivity measurement and standardization; Instrumentation and monitoring techniques; and other applicable training.

When & Where Trained	Duration & Type* of Training	Topics

*Please indicate classroom (formal) courses only.

Statement of Experience with radioactive materials (actual use or equivalent experience, minimum of 20 total hours):

Provide the following information and documentation substantiating your experience --

Isotope	Activities Used (mCi)	Type of Use	Date, Duration & Location of Experience

ISOTOPE PAGE

PURPOSE

The RSC must review the isotope, form, use, and possession limits to ensure that MU does not exceed the limits set by the licenses and registrations.

Information on special uses involving radioactive materials must be reviewed by the RS Office to ensure all aspects of a safe work environment are being evaluated and met.

COMPLETING THE ISOTOPE PAGE

Radioactive Material Requested:

List each isotope separately. List one of the following forms for each of the isotopes listed:

- activation byproduct, any form,
- activated or contaminated,
- contained source,
- daughter product,
- generator,
- isotope kit,
- microsphere,
- plated source,
- seed,
- source foil,
- slug,
- or sealed source

Provide requested order limit and possession limit in milliCuries for each listing. The order limit cannot exceed the possession limit of the specific authorization.

Use of Radioactive Material:

Provide general description of each use as it relates to the safe handling for each of the listings.

The following generic procedures need only be identified:

- Northern blot,
- Southern blot,
- Western blot,
- Hybridization,
- Soil moisture gauge use,
- Iodination,
- Soil density gauge use,
- Gas chromatograph electron capture foil use.

Identify all the special uses requiring additional controls and provide a written description of each special control in accordance with the following:

Biohazards -- If work will involve the use of biohazards, describe:

- The biohazards/safety procedures/special waste handling,
- The use procedure(s) involving the biohazards,
- The radiation safety procedures involving biohazards.

Hazardous Materials -- If work will involve the use of hazardous or dangerous chemicals, describe:

- Registered User (RU) name and RU Number,
- Hazardous material use/safety procedures/mixed (hazardous +

radioactive) waste handling & accumulation,

- The use procedure(s) involving hazardous materials,
- The radiation safety procedures involving hazardous materials.

Airborne hazards -- If work will involve the powdery, volatile, or other airborne forms of radioactive materials, describe:

- Airborne safety procedures fume hood or glove box facilities**,**
- The use procedure(s) involving airborne radioactive materials,
- The radiation safety procedures for airborne radioactive materials.

High energy Beta's (P-32 or higher) greater than 5 mCi -- If P-32 or other high energy beta emitter will be used, describe:

- The procedures used to minimize & detect contamination,
- The procedures used to minimize exposure (including use of plastic shields),
- The maximum activity in any stock solution,
- The maximum activity in any other container storing solutions or waste,
- The proposed storage and usage in each room or area,
- The individuals who will be handling greater than 5 mCi of P-32.

I-125 or I-131 in quantities that are greater than 1 mCi – If you plan to iodinate, use or store radioiodines, describe:

- The radionuclide involved and procedure(s) used;
- The maximum activity involved with iodination;
- The proposed storage, usage, or iodination in each room or area;
- The maximum activity in any container storing solutions or waste;
- The individuals who will be handling greater than 5 mCi of radioiodine.

H-3 -- If using quantities that are greater than 100 mCi of tritiated water or sodium borohydride, or greater than 25 mCi of tritiated organic material , describe:

- The maximum activity in any container storing solutions or waste,
- The storage and usage in each use area,
- The individuals who will be handling these materials.

Gamma emitters with energies greater than 500 keV, describe:

- The maximum activity in any container storing solutions or waste,
- The proposed storage and usage in each use area,
- The individuals who will be handling gamma emitter's quantities greater than 5 mCi.

Long Lived Isotopes, describe:

- The maximum activity in any container storing solutions or waste,

- The specific lab procedures to prevent or eliminate any long-lived contamination of the laboratory,
- The procedures or use protocols to assist in the future laboratory close out or decommissioning.

Sealed Sources -- If you plan to use radioactive sealed sources or gas chromatograph sources, list for each:

- The isotope;
- The last calibration date and associated activity;
- The manufacturer, model, and serial number;
- Locations of storage and use.

Food items or food container use -- If you plan to use any food items or food containers, describe:

- The specific food item(s) used,
- The food container(s) used,
- Purpose for use,
- The locations of storage and use,
- The labeling precautions taken to ensure no consumption by humans occur.

Live plant use -- If you plan to conduct experiments involving radioactive materials in live plants, describe:

- The plant type(s),
- The radioactive materials used,
- The use procedure(s) involving plants,
- The location(s) of the plants,
- The individuals providing care for the radioactive plants,
- The radiation safety procedures involving the plants, including radioactive waste management.

Animal use -- If you plan experiments involving radioactive materials in live animals, describe:

- The animal type(s) and animal protocol number for each vertebrate type,
- The radioactive materials used,
- The use procedure(s) involving live animals,
- The location(s) of animals,
- The individuals providing care for the radioactive animals,
- The radiation safety procedures involving animals, including radioactive waste management.

Human use -- If you are applying to use radioactive materials in or on humans, provide copies of the following:

- Board Certification(s),
- State Medical License Registration(s).

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

ISOTOPE PAGE

[*This form or attachment must be typed or printed very neatly in black ink*]

Radioactive Material requested:

Isotope	Form	Order Limit (mCi)	Possession Limit (mCi)

Use of Radioactive Material: [Form or attachment must be typed or very neatly printed in black ink]

Attach the use protocol(s) planned for each isotope and the associated radiation safety procedures unless you utilize one of the "generic" procedures.

[ ] Generic procedure(s) to be used as noted --

Isotope	Generic Procedure(s)

Special uses requiring additional controls -- provide written description(s) of the additional controls for each special use noted here (See How to Complete Authorization Application Isotope Page)

[ ] Biohazards
[ ] Hazardous materials/mixed waste
[ ] Airborne hazards
[ ] High energy beta (P-32 or higher) greater than 5 mCi
[ ] I-125 and/or I-131 greater than 1 mCi
[ ] H-3 greater than 25 mCi
[ ] Gamma emitters w/ E greater than 500 keV
[ ] Long-lived isotopes (Half life greater than 120 days)
[ ] Sealed Source/Foil
[ ] Food stuffs or food container use
[ ] Live plant use
[ ] Animal use
[ ] Human use
[ ] Dosimetry Requirements

RADIOACTIVE MATERIAL LOCATION PAGE

PURPOSE

The RS Office must review your facilities and equipment to determine their adequacy for the isotopes and the type of work you are requesting. The need for special security, posting or monitoring equipment will be determined.

The RSC reviews the adequacy of the facilities and equipment for each authorization application.

ROOM AND AREA INFORMATION

Each room or area will be reviewed and approved on an individual basis. Rooms will be designated as restricted areas and the storage and use of radioactive materials is approved anywhere within the restricted area.

Information concerning the surrounding areas is needed to help locate the room and to assess safety concerns (e.g., radiation levels, contamination control, etc.). Information on the location of the radioactive work areas, storage areas, and other items on the identification key should be submitted with the application. These locations may be moved anywhere within the restricted area without need of an authorization amendment.

TRANSITORY USE AREA

Transient use areas are areas where radioactive materials are used for infrequent and short periods of time (<8 hours). All materials must be secured by physical means or by maintenance of a constant line-of-sight. At the end of each work period a documented survey must be performed to confirm that contamination is not present. These areas do not require posting. Additional or different conditions may be outlined in the individual authorization.

MODIFIED RESTRICTED AREA

To request a modification of a restricted area:

- Explain the purpose for requesting a modification of restricted area.
- Provide a floor plan of the entire restricted area and surrounding areas, identifying all doors securing the area, and marking what areas within the current restricted area will remain as the restricted area and what areas will remain the non-restricted.
- Describe how security to the modified restricted area will be maintained.
- If food and drink are to be allowed in the non-restricted area, explain how the food and drink will be brought into that area, and how the food and drink will be kept completely out of the proposed restricted area.
- Explain how all individuals having access to the modified restricted area will be trained to know and understand their responsibilities with regard to compliance with the special conditions governing the area.
- Before the application is forwarded to the RSC, it will be reviewed and approved for by all Environmental Health and Safety (EHS) groups (i.e., Radiation Safety, Environmental Management Services, Industrial Hygiene/Biosafety, and General Safety). If compliance issues are identified for any safety issue, the application for restricted area modification will not be supported. Once a restricted area modification has been granted, any deficiency identified with compliance of the special conditions governing that area could result in the withdrawal of the approval.

COMPLETING THE RADIOACTIVE MATERIAL LOCATION PAGE

Complete separate form for each room or area.

Provide a floor plan identifying the items listed in the Identification Key. Plan should be a "to scale" floor plan with room dimensions.

Provide information on how security of radioactive material will be maintained when authorized personnel are not present.

Identify how the area will be used by checking the appropriate box(s) on the form.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

RADIOACTIVE MATERIAL LOCATION PAGE

[*This form or attachment must be typed or printed very neatly in black ink*]

Complete separate sheet for each room

Building: Room Number:

Floor plan of total room(s) containing restricted area and identify surrounding areas (include overall dimensions)

Identification Key
B = bench top
C = centrifuge
D = desk
DH = door handle
E = emergency proc.
EE = electrophoresis
F = floor
FR = freezer
H = hood
HS = heat sealer
L = laminar flow hood
M = μ centrifuge
O = oven/incubator
R = refrigerator
S = sink
SA = storage area
SH = shields
T = telephone
WA = waste area

What level of security will be maintained for radioactive materials when authorized personnel are not present?

[ ] All radioactive materials (including waste) will be stored in locked cabinet(s), refrigerator(s), or freezer(s).
[ ] The room will be locked.
[ ] Other (specify).

This room is requested:

[ ] for use as a radioactive work area
[ ] to contain a modified restricted area as described above
[ ] for a common use area
[ ] for storage only
[ ] for use as a transient radioactive work area
[ ] for other (specify)

RADIATION SURVEY INSTRUMENTATION PAGE

PURPOSE

The RS Office and the RSC must review your survey instrumentation to determine the adequacy of the instrument for the isotopes and the type of work you are requesting to do.

COMPLETING THE RADIATION SURVEY INSTRUMENTATION PAGE

Provide requested information for each radiation survey meter.

If you need to obtain a radiation survey meter, contact your assigned HP for ordering information.

Uncalibrated survey meters will not be approved for use in radiation safety surveys.

Provide requested information for each counting system you plan to use.

If you need assistance in identifying a counting system for your use, contact your assigned Health Physicist for a nearby system location or information concerning the purchasing a new instrument.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

RADIATION SURVEY INSTRUMENTATION

[*This form or attachment must be typed or printed very neatly in black ink*]

Radiation survey meter

For Beta or Gamma Emitters

[ ] Manufacturer:

Model No.: Serial No.:

Detector Type or Model No.:

[ ] Manufacturer:

Model No.: Serial No.:

Detector Type or Model No.:

Counting Equipment

[ ] Beta Counter (Liquid Scintillation Counter or other)

Location:

Manufacturer:

Model No.: Serial No.:

[ ] Gamma Counter

Location:

Manufacturer:

Model No.: Serial No.:

ANTICIPATED TRANSACTIONS PAGE

PURPOSE

The RS Office must review your anticipated receipts, transfers (on or off license) and generation of waste. This is needed to determine what kind of radiation safety support is necessary and if we have the facilities, equipment, and staff to provide it.

The RSC reviews the adequacy of the radiation safety support for each authorization application.

COMPLETING THE ANTICIPATED TRANSACTIONS PAGE

Estimated Use

List for each isotope the estimated number of shipments and total activity you anticipate receiving each calendar quarter.

Do not include any transfers of radioactive material from other MU AU's in this section.

Planned Transfers In or Out

If you plan to receive or transfer radioactive materials to other MU AU's, provide the following information for each supplier or recipient:

- Estimated generation of radioactive waste,
- The type(s) of radioactive waste you anticipate generating: animal (carcass, waste and bedding), Mo-99 generator, liquid (jugs), liquid (stock), liquid (vials), seeds, solid, or other.
- The estimated volume per month for each waste type checked, and for each applicable isotope.
- Please estimate your waste generation volumes in the following units:
    - Solids in cubic feet,
    - Liquids (jugs) in gallons,
    - Liquids (vials) in gallons,
    - Liquids (stock) in gallons,
    - Animal in kilograms,
    - Seeds in number of seeds.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

ANTICIPATED TRANSACTIONS PAGE

[*This form or attachment must be typed or printed very neatly in black ink*]

Estimated use:

Isotope	Shipments/Quarter	Activity received/Quarter

Planned Transfers In or Out:

If you plan to receive or transfer radioactive materials to other Authorized Users, list the following data for each supplier or recipient: [Attachment must be typed or very neatly printed in black ink]

a. Name and address of supplier or recipient.

b. Radioactive isotope(s) to be transferred.

c. Estimate of activity(s) to be transferred and an annual estimated total activity to be transferred.

Estimated Generation of Radioactive Waste:

Provide estimated volume per month for each waste type checked:

[ ] No radioactive waste to be generated:
[ ] Solid (cubic feet): _____
[ ] Liquid (jugs - gallons): _____
[ ] Liquid (vials - gallons): _____
[ ] Liquid (stock - gallons): _____
[ ] Animal (kilograms): _____
[ ] Seeds (number of seeds): _____
[ ] Other (describe): _____

TEMPORARY TRANSFER OF AUTHORIZATION PAGE

PURPOSE

Any AU who plans to be away from MU for greater than 30 continuous days must either inactivate the authorization or temporarily transfer authorization responsibilities to another AU.

Please arrange for the temporary transfer at least two weeks before you depart so that the inactivation can be completed or the authorization responsibilities can be transferred to another AU in a timely manner.

COMPLETING THE TEMPORARY TRANSFER PAGE

Transferring AU Data

Provide full name and Authorization Number. Describe purpose for absence, provide the date that the transfer will begin and the anticipated end date.

Personal Data for the Substitute AU

Provide requested information about the substitute AU taking over the authorization..

Substitute AU Statement

Signing the Substitute AU Statement confirms acceptance of the stated responsibilities.

Approval of Direct Supervisor

Provide name and department of the Transferring AU's Direct Supervisor.

Signing by the Direct Supervisor indicates support for this temporary transfer.

UNIVERSITY OF MISSOURI

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS

Authorization Number: **Application Date:**

TEMPORARY TRANSFER OF AUTHORIZATION PAGE

[*This form or attachment must be typed or printed very neatly in black ink*]

Transferring Authorized User

Name:

Purpose of absence:

Planned Period of Absence From: To:

Personal Data for Substitute Authorized User:

Authorized User to whom authorization is being temporarily transferred. This individual should have experience with similar radioactive materials and responsibility for labs in the vicinity of the transferred authorization.

Name: Authorization Number:

Department/Unit:

Office Address:

E-Mail Address:

Office Telephone: Lab Telephone: FAX:

Substitute Authorized User Statement

I understand and accept my responsibility to the best of my knowledge as a Substitute Authorized User to act in the name of the Authorized User during this period of absence.

_____ _____

Substitute Authorized User Signature Date

Approval of Direct Supervisor for Transferring Authorized User

Name:

Department:

I support this temporary transfer.

_____ _____

Direct Supervisor Signature Date

HOW TO TRAIN RADIATION WORKERS

GENERAL

The Training Guide for RW's, is a suggested format for the required training of all RW's under the AU's authority prior to their use of radioactive materials. This guide also provides a mechanism to do authorization specific annual training, as recommended by the RSC.

This training should be performed by the AU, but can be delegated to laboratory supervisors who are approved as RW's and are cognizant of all of the requirements and commitments of the authorization. Training Records shall be retained for 3 years by the AU and a copy of the training shall be sent to the RS Office upon completion of the training.

Individuals must attend formal training through the MU Radiation Safety Training Program prior to or soon after being registered as a RW.

All RW's are required to periodically update their formal training through the MU Radiation Safety Training Program.

RADIATION PRINCIPLES AND TERMINOLOGY THAT ALL RW MUST KNOW

Discuss the Following;

- Basic radiation principles: isotopes approved under the authorization, and their types of radiation emissions, particles/photon.
- Basic radiation protection principles: time, distance, shielding, dose calculations from exposure measurements (TEDE, CEDE), radiation measurements, and posting and labeling requirements including.
- Basic radiation units: rad, rem, roentgen, curie, Becquerel, dpm, and multiples; e.g., milli-, micro-, Mega-, etc.
- The ALARA (As Low As Reasonably Achievable) concept of reducing personnel exposures.

Explain how to perform and document radiation surveys, action levels, when to contact the RS Office, and any specific requirements of the laboratory program.

Discuss the isotopes in use in the laboratory and the ability to detect them by different methods.

Discuss the use of the various isotopes of the authorization, their half-life, activity calculations, specific handling and detection procedures, waste minimization techniques, disposal procedures, and mechanisms for meeting the unwanted Hazardous Material requirements.

10 CFR PART 19 INSTRUCTIONS

Discuss the Following;

- Title 10 Part 19 (10 CFR 19) regulatory terminology,
- NRC form 3, RW's rights and responsibilities,
- Where the regulations can be located.

Risks associated with radiation exposure are discussed in the NRC Regulatory Guide 8.29, "Instructions Concerning Risks for Occupational Radiation Exposure."

DOSIMETRY

The RW should be able to describe;

- Basic radiation dosimetry,
- Who wears dosimetry - why and why not,
- Terminology of reports and how to wear and store dosimetry,
- When and how to return the assigned dosimetry back to the RS Office,
- When and how to request bioassay procedures if trigger levels are exceeded or if uptake, intake or ingestion of radioactive materials is suspected,
- The declared pregnant worker program and the need to contact the RS Office if a pregnancy occurs or is anticipated.

EMERGENCY PROCEDURES

Discuss the following with the RW:

- The laboratory specific and generic radiation emergency procedures to limit the spread of, and to control personnel contamination in the event of an accident involving radioactive materials;
- Reinforce the need to contact the RS Office directly, or by contacting the MU Police, if action levels are exceeded or spread of material beyond the AU's control is suspected;
- The Posted Fire, Medical Emergency, and Hazardous Material emergencies involving or not involving radioactive materials. Note the RS Office provides a Radiation Emergency Procedures Flyer to each Authorization.

LABORATORY/AUTHORIZATION SPECIFIC ITEMS

Review the authorization as issued by the RSC:

- Isotopes,
- Possession limits,
- Chemical/physical forms,
- Material uses,
- Any conditions stated in the application or in the Authorization Form.

Review the basic laboratory safety rules for:

- Radioactive material,
- Chemical,
- Biological,
- Infectious material,
- Prudent safety practices for proper laboratory apparel.

Discuss the laboratory specific procedures for:

- Ordering,
- Receipt,
- Transfers of radioactive material under the requirement of the RSM.

Discuss and demonstrate the procedures for maintaining:

- Radioactive material receipt,
- Inventory,
- Use records for the laboratory,
- Include the requirement for decay correcting and maintaining inventory of material in stock, use and waste.

Discuss and demonstrate the procedures for managing:

- Radioactive waste,
- Inventory maintenance and decay,
- Pickup request,
- Documentation of the disposal.

Note that the waste remains on the AU's inventory until it has been removed from the laboratory by EHS.

Review when to notify RS Office for:

- Contamination events,
- Spills,
- Personnel contamination events,
- Other emergency situations.

Demonstrate and observe the performance of:

- Survey meter use,
- Swipe surveys and their analysis,
- "After each use" monitoring,
- Overall laboratory survey,
- Procedures for documenting surveys.

DOCUMENTATION

- Have the RW complete the 5 question test.
- Discuss the answers and any other questions that may have arisen.
- Provide the signatures and printed data requested.
- If you want this training documentation tracked in EHS's training records, mail a copy of the completed form to: EHS Training Coordinator, # 8 Research Park Development Building.
- Retain the record for three years.

TRAINING GUIDE FOR RADIATION WORKERS
(Type or Print Clearly)

The following checklist of training items is a suggested format for required training to all Radiation Workers under the Authorized User's (AU's) authority ***prior*** to using radioactive material without direct supervision of the Authorized User or another approved Radiation Worker. The training should be performed by the AU but can be delegated to laboratory supervisors who are approved as Radiation Workers (RW's). Training records must be documented, dated and retained in the AU's records for 3 years. A copy may be sent to the RS Office for record retention.

The following items should be covered to the extent appropriate, according to the Radiation Worker's assigned responsibilities, for all personnel working with or surveying for radioactive materials:

DATE	**TOPIC**
____	Basic radiation principles; types of radiation, particle / photon emissions.
____	Radiation protection; time, distance, shielding, dose calculations, radiation measurements, area postings (signage).
____	Radiation units and terminology; including rad, REM, roentgen, curie, etc.
____	Description of ALARA concept.
____	10 CFR Part 19 requirements, regulatory terminology, NRC form 3, rights of RW's, where is the regulation located, and recommended areas to post NRC form 3 in your laboratory.
____	Radiation dosimetry; dosimetry terminology, how to wear dosimetry, bioassay, declared pregnant worker program, fetal dosimetry, terminology (TEDE, CEDE).
____	Emergency response procedures involving radioactivity; Fires, injuries, major and minor spills, spill response, notification and clean up procedures.
____	Instructions on how to perform radiation surveys and what are any specific requirements for the area.
____	Description of the various isotopes used in the laboratory; handling procedures, waste minimization strategies, disposal and precautions associated with specific isotopes.
____	Review the Authorization documentation; applications, authorizations, conditions necessary to maintain compliance, basic lab rules (lab coats, eye protection, eating restrictions, and open toed shoe restrictions), etc.
____	Procedures for ordering, receipt and transfer of radioactive materials.
____	Record keeping requirements; inventories, training, etc.
____	Instructions on managing radioactive waste, requesting a pickup and disposal documentation.

TRAINING GUIDE FOR RADIATION WORKERS – CONTINUED

____ Notification requirements; when to call the RS Office.

____ Observe and demonstrate the appropriate technique for checking and using a survey meter.

____ Observe and demonstrate the appropriate use of a liquid scintillation counter; discuss windows, protocols, efficiencies, dpm vice cpm, trigger levels, and false positives and appropriate corrective actions.

____ Observe and demonstrate the appropriate use of any other method of counting used. The use of a type counter was demonstrated.

____ Observe and demonstrate the procedure for performing a laboratory survey for contamination and discuss trigger levels.

____ Emphasize the importance of dry runs and cold runs prior to performing each type of experiment.

1) What does ALARA stand for? _____

2) What are the colors of a "CAUTION RADIOACTIVE MATERIALS" sign? _____

3) What can you do to minimize your dose from radioactive materials? _____

4) Can beta radiations from tritium, carbon-14 or sulfur-35 penetrate the skin? _____

5) What unit is used to measure activity? _____

I understand and have demonstrated the noted training topics.

Print Name: _____ Employee/Student Id: _____

Signature: _____ Date: _____

Print Trainer's Name: _____ Employee/Student Id: _____

Trainer's Signature: _____ Date: _____

Authorized User Name: _____ Au #: _____

Course Id: _____ Course Hx: _____ Date Entered: _____ Initials: _____

HOW TO TRAIN ANCILLARY WORKERS

The following items should be covered for all personnel frequenting areas where radioactive materials are used (students, secretaries, custodians, RW's, etc.).

RESPONSIBILITIES

The training of the Ancillary Workers should be performed by the AU but can be delegated to laboratory supervisors approved as RW's. Training records must be documented, signed, dated, and retained by the AU for 3 years. An additional copy shall be sent to the RS Office.

EXISTING HAZARDS

Ancillary Workers are required to know the hazards which they may encounter in the laboratory, the individuals responsible for the work in the areas, and who to contact if they suspect that a problem may exist or if an accident occurs. It is recommended that this information be presented and reviewed annually.

Walk around the laboratory with each new Ancillary Worker; discuss all hazards - including radioactive materials, radio toxicities, radioactive detection methods, hazardous chemicals, infectious and other physical hazards. Demonstrate normal work conditions and introduce them to the persons responsible for the work area(s) so that they know whom to contact if they suspect a problem or have questions of a safety nature.

Discuss the requirements and mechanisms for security of radioactive materials, and prohibition of food and drink in restricted areas.

WARNING AND POSTING

Review the importance of the laboratory posting, any specific authorization modifications, and the laboratory rules for Radiation Safety.

Identify radioactive material caution labels on packages, work areas, equipment, samples and review and discuss the NRC Form 3 "NOTICE TO EMPLOYEES".

Review your laboratory specific spill and emergency procedures along with the posted Radiation Emergency Procedures. Include instructions on when to contact other lab personnel, when to call 911, and when and how to contact RS Office.

GUIDELINES

The training must be extremely clear as to what they are allowed to do in the various laboratory areas. They may be asked by an inspector what they can or cannot do.

The "Training Guide for Ancillary Personnel" checklist of training items is a suggested format for the required training of all ancillary personnel under the AU's authority, prior to working without direct supervision in any area where radioisotopes are used.

Common radioactive isotopes that the AU is allowed to use under the authorization can be found on the Radiation Safety Web Page resource section.

DOCUMENTATION

Have the worker complete the three question test. Discuss the answers and any other questions or concerns that they may have.

Provide the signatures and printed data on the form. If you want this training documentation tracked in EHS's training records, mail a copy of the completed form to: EHS Training Coordinator, # 8 Research Park Development Building. The training record must be maintained for three years.

TRAINING GUIDE FOR ANCILLARY PERSONNEL

The following checklist of training items is a suggested format for the required training for all ancillary personnel under the Authorized User's (AU's) authority ***prior*** to working, without direct supervision, in an area where radioisotopes are used. The training should be performed by the AU but can be delegated to laboratory supervisors approved as RW's. Training records must be documented, signed, dated and retained in the AU's records for a minimum of 3 years.

The following items should be covered for all personnel frequenting area where radioactive materials are used (students, secretaries, custodians, radiation workers, etc.):

DATE **TOPIC**

____ Demonstration of the types of radioactive materials used in the lab; this can be done by using survey meters or other suitable measuring equipment.

____ Show personnel where radioactive materials are used, stored and disposed.

____ Instructions regarding the necessity of maintaining security of radioactive materials.

____ Instructions regarding the requirement of no eating, drinking and other hygienic use issues while in lab.

____ Show some examples of various signage's' they might encounter and explain the meaning of these signs.

____ Explain the actions and use of the procedures necessary in the event of a spill or other unusual occurrence. Who to notify and how to control access.

1. Circle the radiation symbol. ϖ ☯ ® ✷

2. Is it alright to eat your lunch at your desk in a radiation laboratory? _____

3. Who should be notified in the event of a spill in this area? _____

The above items have been described and understood by me.

Print Name: _____ Employee/Student Id: _____

Signature: _____ Date: _____

Print Trainer's Name: _____ Employee/Student Id: _____

Trainer's Signature: _____ Date: _____

Authorized User Name: _____ Au #: _____

Course Id: _____ Course Hx: _____ Date Entered: ____/___/_____ Initials: _____

REGISTERING RADIATION WORKERS AND ORDERING PERSONNEL DOSIMETRY

PURPOSE

The Radiation Worker Dosimetry Application Form, is used to register a RW under a given authorization, and if appropriate, order dosimetry for that individual. A separate form must be submitted for each individual working under a given authorization.

A separate form must be submitted for each authorization under which the RW is working. By signing this form, RW's are authorizing the release of their previous radiation exposure records for MU records. RW's are also verifying that they have been trained, and understand and accept the responsibilities appropriate to their use of radioactive materials. By signing this form, AU's are confirming that the RW has been trained in the authorization-specific radiation safety procedures. The AU's are also approving and accepting responsibility for this RW to handle radioactive materials under their authorization.

Only one form needs to be submitted for each RW under a given authorization, unless changes need to be made in the assignment of personnel dosimetry. To obtain dosimetry for personnel who will only be exposed to x-ray radiation, please contact the RS Office at 882-7221 to obtain the proper form.

AUTHORIZATION-SPECIFIC FORMS

The Radiation Worker Dosimetry Application Form, shown in this manual is a generic form. A form specific for each authorization may be issued with the group's data and dosimetry series code already printed. This specific form will be stamped in red with: "MASTER COPY". Alternatively, the AU may use the blank form available on the Radiation Safety web site at http://ehs.missouri.edu.

HOW TO FILL OUT THE RADIATION WORKER APPLICATION

Complete **Items 1-6** as indicated on the Form for RW and/or dosimetry requests. NOTE: You must include your university ID number if you are requesting dosimetry. If no dosimetry is required then the registering individual can use his or her student or employee identification instead of their SSN Both RW applicants and those requesting dosimetry must complete items 1 – 6.

If you do not have a "MASTER COPY" and **Items 7-10** are blank, you must complete them.

Radiation Workers

Item 11: Indicate the formal Radiation Safety training courses that you have attended; the location, contact hours, and the date of the class or workshop.

Item 12: Indicate the actual on the job, isotope handling experience that you have acquired, also list the isotopes, chemical/physical forms, maximum activities that you have processed location of that use, type of use, and dates.

Item 13: Indicate the isotopes and activities that you are expecting to handle under this authorization.

Item 14: To be registered as a RW, you must indicate that you have received authorization-specific training from the AU or their staff covering radiation safety, laboratory safety, and your worker responsibilities. Be sure to include the dates of the training.

All applicants must read the responsibilities statement and then sign and date the form (item 15).

All applicants using radioactive material must have their AU agree to the responsibilities statement and sign the form (item 16).

Dosimetry Application

Dosimetry Information (complete only if you are requesting dosimetry).

Circle the action you wish to take (Add, Delete, Change or Transfer). Attach a note if applicable.

Circle the dosimeter type(s) you wish to order. If ordering a fetal dosimeter, you must first contact your assigned HP.

If a Series Code is not printed, your lab/department does not have dosimetry service. Contact either your assigned HP or call the RS Office at 882-7221.

Check the appropriate Dosimetry History Information box and complete the employer information if required.

If you begin working for a separate agency that requires dosimetry monitoring while you are still employed at MU, you must contact the EHS office. EHS is required by the NRC to contact the second employer periodically for exposure information.

You can either mail or fax the form to: Radiation Safety Office, #8 Research Park Development Building, and Phone: 882-7221, Fax: 882-7940

REMOVAL OF RADIATION WORKERS

When a RW is no longer working under an authorization, please contact your assigned HP at the RS Office at 882-7721 to have that individual's registration closed out for that authorization.

RADWORKER AND DOSIMETRY APPLICATION

UNIVERSITY OF MISSOURI – COLUMBIA

Environmental Health and Safety, 8 Research Park Development Building, Columbia, MO 65211-3050
Phone (573) 882-7221 *Fax (573) 882-7940*

RADWORKER APPLICATION

Directions: Complete items 1-16 to become a RadWorker under an Authorized User. *Shaded areas are **REQUIRED** fields.* Please type or print clearly.
Only complete Dosimetry Information (below) if a personal dosimeter is required.

1.-Worker Name	2.-Job Classification	3.-Date / /
4.-Birthdate / /	5.-Social Security Number	6.-Sex Male ☐ Female ☐
7.-AU Office/Laboratory Phone /		
8.-Department	9.-AU Address	10.-Authorized User
AU No.		

11.-Radioactive Material Training Classes	Where Trained	Contact Hours	Date
			/ /
			/ /

12.-Radioactive Material Handling Experience

Radioisotope	Form	Activity Used (mCi)	Where Gained	Type of Use	Dates
					/ / to / /
					/ / to / /

13.-Radioactive materials and quantities to be used at MU

14.-Worker instructed by Authorized User or staff on laboratory safety, radiation safety and worker responsibilities? Yes ☐ Date / /
Comments:

15.-Radiation Worker's Signature _____Date ____/____/____
Radiation Worker – I have been trained and understand and accept my responsibilities appropriate to the use of Radioactive Materials.
I authorize the release of my radiation exposure records (internal and external) to the RSO of the University of Missouri-Columbia.

16.-Authorized User's Signature _____Date ____/____/____
Authorized User - As identified above, I approve and accept responsibilities for this individual to handle RAM under my Authorization.

DOSIMETRY APPLICATION

Directions: Only complete this portion to add, change or transfer a required personal dosimeter.

CIRCLE CHOICES
ADD DELETE CHANGE (Attach Note) TRANSFER (Attach Note)

Dosimeter Type to ADD: Whole Body (Chest) Extremity Ring (Sm. Med. Lg.) Fetal Dosimeter (Contact Your Assigned HP)

Dosimetry Series Code: **Assigned Health Physicist:** **Dosimetry Frequency:**

Dosimetry & radiation exposure history information: Check the box(s) below that apply.

- ☐ *I was required to wear a dosimetry monitoring device during this year (complete employer information below).*
- ☐ *I was assigned a dosimeter at a previous employer (complete employer information below).*
- ☐ *I am currently monitored by another employer (complete employer information below).*
- ☐ *I have never been monitored for radiation exposure.*

Previous Employer Name: _____

Street Address: **City** **State** **Zip**

Health Physicist Approval

Date received ____/____/____ Date evaluated ____/____/____ HP Signature _____

Up to date forms are available at http://ehs.missouri.edu/rad/forms.html

DECLARATION OF PREGNANCY AND ORDERING FETAL BADGES

GENERAL

Generally, RW's are limited to 5000 mrem/year Total Effective Dose Equivalent (TEDE). However, females who declare that they are pregnant are offered additional protection to the developing fetus. The limit is 500 mrem TEDE for the declared gestational period. This limit exists due to the fact that rapidly developing cells are generally more vulnerable to biological insult than less rapidly growing cells, regardless of the type of insult (radiological, chemical, viral, etc.). The following steps should be taken in order to gain the information necessary to make an informed decision regarding the risks of working with radioactive materials during pregnancy.

The individual makes an appointment with a HP or the RSO (882-7018) to discuss the risks of ionizing radiation during pregnancy. See NRC Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" for additional information.

The individual can decide whether or not to declare a pregnancy. If the individual decides to declare the pregnancy, then she must fill out and sign the "Declaration of Pregnancy" Form provided by the RS Office. If she chooses not to declare her pregnancy, she may still request a fetal badge to measure external exposure to the fetus. However, as a non-declared pregnant woman, her annual dose limit will remain at the 5000 mrem.

DOSIMETRY

The pregnant worker will be issued an embryo/fetus badge, similar to the badge she is already wearing, for use in monitoring the external exposure levels to the fetus.

Need for monitoring internal dose to the fetus will be assessed based on the pregnant worker's possibility of having intake of radioactive materials.

The results of her monitoring will be reported on a monthly basis throughout the remainder of the gestation period. Consult with your assigned HP with any questions regarding the procedure.

DECLARATION OF PREGNANCY

10 CFR 20.1003 DEFINITIONS -- DEFINES A DECLARED PREGNANT WOMAN AS FOLLOWS:

"Declared pregnant woman means a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant."

10 CFR 20.1208 DOSE TO AN EMBRYO/FETUS -- STATES:

(a) The licensee shall ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv).

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose to the embryo/fetus shall be taken as the sum of--
(1) The deep-dose equivalent to the declared pregnant woman: and
(2) The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclide's in the declared pregnant woman.

(d) If the dose to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with the paragraph (a) of this section if the additional dose to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

I,_____, (Print Last Name, First Name, MI) have read the above Nuclear Regulatory Commission definition of a "DECLARED PREGNANT WOMAN" and section 10 CFR 20.1208 on the dose to an embryo/fetus and understand them. By declaring my pregnancy in writing, I understand I have reduced my maximum permissible deep-dose equivalent exposure to 0.5 rem (5 mSv) during the entire gestation period from that of a non-pregnant woman. With this understanding I am voluntarily informing the University of Missouri that I meet the NRC definition and request that a fetal dosimeter is issued to me. I estimate that the date of conception to be on or about __/__/__.

_____ Date: _____
Signature of the Applicant

Identification Number: _____ Code: _____

Badge Account: 3200 Series: _____ Badge No.: _____

_____ Date: _____
Signature of the Radiation Safety Officer or designee.

WHEN USE OF RADIOACTIVE MATERIALS REQUIRES BIOASSAYS

GENERAL

Generally bioassays should be performed within seven (7) days after use of specified quantities of tritium (H-3) or within ten (10) days of specified quantities of radioiodines. The activity level is determined by the way in which the isotopes are used i.e. either in fume hoods or in open bench conditions.

ISOTOPES

H-3 in an Uncontained Form:

A bioassay *shall* be performed within 7 days for the following:

- When greater than 0.250 mCi of material may have entered the body through absorption, ingestion, injection or other accidental deposition,
- When greater than 10 mCi of material is processed in an open room,
- When greater than 100 mCi of material is processed in an operating fume hood.

I-125 or I-131 in an Uncontained Form:

A bioassay shall be performed immediately when greater than 0.100 microCurie of material may have entered the body through absorption, ingestion, injection or other accidental deposition.

A bioassay shall be performed within 10 days for the following:

- When greater than 1.0 mCi of material is processed in an open room,
- When greater than 10.0 mCi of material is processed in an operating fume hood.

TO SCHEDULE A BIOASSAY

If you have questions regarding the need for bioassays or to schedule one, contact your assigned HP at 882-7221. Bioassays are conducted routinely throughout campus and one can usually be scheduled to meet your needs. Describe the isotope, activity and date the material was handled within the time frames mentioned above.

ALARA REPORTING

GENERAL

The ALARA (As Low As Reasonably Achievable) program sets personnel dose levels, well below the annual regulatory limits, where an investigation will be initiated to determine the cause of the dose, and dose reduction can reasonably be done.

ALARA INVESTIGATIONAL LEVELS

The ALARA investigational levels are listed in ALARA Investigation Levels. The NRC limits are presented below for comparison.

Doses reported by dosimetry vendor are used to determine if ALARA levels have been exceeded. Different ALARA levels have been established for specific groups. Contact the RS Office for further information concerning these specific groups or the establishment of different ALARA levels for a new group.

REPORTS AND INVESTIGATIONS

A Quarterly Report of all individuals who have exceeded quarterly ALARA Levels is provided to the RSC.

An ALARA Investigation Report may be sent to individuals who exceeded any ALARA Level. The individual is asked to complete the ALARA Report describing the type of work that was performed during the monitoring period and, if possible, to identify ways to reduce future exposure. This report is to be signed by the individual, individual's supervisor, and the RSS person who conducted the investigation. The returned reports are then filed with the individual exposure records.

NRC DOSE LIMITS (10 CFR 20)

Area of Dose	Occupational Dose Limits (mrem/year)	Public Dose Limits (mrem/year)
Total Effective Dose Equivalent (or Whole Body: external + internal)	5,000	100
Committed Dose Equivalent (or any organ dose)	50,000	NA
Eye Dose Equivalent (or lens of the eye)	15,000	NA
Shallow Dose Equivalent (or skin dose)	50,000	NA
Extremity Dose (or shallow dose to any extremity)	50,000	NA
Minor (less than 18 years of age)	10% of Occupational limits	NA
Embryo/Fetus of Declared Pregnant Woman (limit taken over time of pregnancy)	500	NA

CONTROL AND SECURITY OF RADIOACTIVE MATERIALS

POLICY

The MU RSP exists to provide safe work conditions and to meet the regulatory requirements in the control and security of radioactive materials. In order to ensure control and security of radioactive materials, the following policy is implemented: Prudent laboratory practice appropriate for the non-radioactive work in the laboratory (e.g., NIH and CDC Biosafety in Microbiological and Biomedical Laboratories; Prudent Practices for Handling Hazardous Chemicals in Laboratories; ACS Safety in Academic Chemistry Laboratories) will be followed. Radioactive materials shall be secured from unauthorized removal or access.

Food and drink shall not be stored or consumed, nor should cosmetics be applied, - in the restricted area, unless radioactive materials are sealed sources.

The restricted area shall include the entire laboratory area (includes rooms to which access can only be made through the laboratory) bounded by walls and a lockable door. A modification to the restricted area may be granted if the AU, department head or other responsible person applies for modifications; the AU or other responsible person submits a written plan for the modification indicating how the modification will not compromise prudent laboratory practices or control and security of radioactive materials, and RSC approves the modifications.

PROCEDURES

AU's are responsible for the security of all radioactive materials in their possession including radioactive waste in storage. NRC regulations allow for the use and storage of radioactive materials in two types of areas:

Restricted Areas

Restricted Area is any area to which access is controlled by the licensee for purposes of protection of individuals from exposures to radiation and radioactive materials (e.g., labs approved for use or storage of radioactive material).

Areas where radioactive materials are routinely used or stored are usually designated as restricted areas. Such areas must have two conspicuous signs at each entryway: first, "RESTRICTED AREA"; and second, "NO EATING, DRINKING, OR SMOKING". AU's may also request the sign, "AUTHORIZED PERSONNEL ONLY". If the area is required to be posted because of the amount of radioactive materials, the conventional radiation caution symbol and the words "CAUTION RADIOACTIVE MATERIAL" must also be posted at each entryway.

AU's are responsible for security of their areas. If the restricted area is required to be posted for radioactive material, the restricted area must be supervised when unlocked, or the radioactive material (stock, samples and waste) must be locked up or otherwise secured from unauthorized removal.

Certain restricted areas which contain very large quantities of radioactive materials may require additional security measures beyond these listed.

Unrestricted / Controlled Areas

Unrestricted Area = access to facilities not controlled for radiation protection.

Controlled Area = access to facilities controlled for any reason deemed necessary by MU.

All licensed materials that are stored in unrestricted or controlled areas must be secured from unauthorized removal from the place of storage. Such areas include locked and labeled "CAUTION RADIOACTIVE MATERIAL" refrigerators, freezers, or cabinets in hallways.

All licensed materials that are not in locked storage in unrestricted or controlled areas, must be under constant surveillance and immediate control of an approved RW or AU at all times.

Radiation levels in unrestricted areas such that no member of the public has potential to exceed 2 mRem in any one hour or 100 mRem/yr

NOTE: Anyone who suspects that radioactive material has been lost or stolen shall contact the RS Office immediately.

POSTING AND LABELING FOR RADIOACTIVE MATERIALS USE LABORATORIES

REQUIREMENTS FOR POSTING

Areas where access is controlled for purposes of radiation protection are designated as RESTRICTED AREAS.

Restricted areas must be posted with the following:

- "RESTRICTED AREA;"
- "NO EATING, DRINKING OR SMOKING;"
- In most instances, "CAUTION RADIOACTIVE MATERIALS;"
- and in some instances, "AUTHORIZED PERSONNEL ONLY."

Postings must be readily visible at the entrance to the area. The posting must be at all doors, portals or other defined entryways into the restricted area for easy visibility, access control, and security of the radioactive material. Control and Security of the radioactive materials must be maintained at all times.

EXCEPTIONS FROM POSTING

Posting, other than one of the four walls, must be approved as a specific modification to the authorization by the RSC.

The "CAUTION RADIOACTIVE MATERIALS" posting may not be required for all areas based on the activities allowed in the room. Contact your assigned HP to learn more about these exceptions.

Areas where radioactive material are used for infrequent short periods of time (<8 hours), where constant line-of-sight control and/or lockable security is maintained, and where the area will have a documented survey confirming that no radioactive material remains in quantities greater than those allowed for unrestricted areas at the conclusion of the use, do not require posting. These areas are known as Transient Use areas.

REQUIREMENTS FOR LABELING

Each container of radioactive material must bear a durable, clearly visible label bearing the radiation symbol and the words "CAUTION RADIOACTIVE MATERIAL".

The label must also provide sufficient information, such as those below, to permit individuals handling or using the containers, or working in the vicinity to take precautions to avoid or minimize exposure.

- The radionuclide(s) present,
- An estimate of the quantity of radioactivity,
- The date for which the activity is estimated,
- Radiation levels,
- Kinds of materials, and
- Mass enrichment.

Prior to removal or disposal of empty uncontaminated containers to unrestricted areas, the radioactive material label must be removed or defaced to clearly indicate that the container no longer contains radioactive materials.

EXCEPTIONS FROM LABELING

Containers holding radioactive material in quantities less than those listed on the Radionuclide Data Sheets. The Radionuclide Data Sheets can be found in the resource section of the RS webpage.

Containers attended by an individual who takes the proper radiation safety precautions.

Containers that are accessible only to authorized individuals if the contents are identified to these individuals by a readily available written record.

EXAMPLE OF POSTING REQUIREMENT

Radioactive material labeling and posting requirements for some typically authorized isotopes are shown below. See the Radionuclide Data Sheets on the RS Offices Webpage or the NRC webpage**,** for this and more information on these and other isotopes. Contact your assigned HP for information concerning labeling and posting requirements for other authorized isotopes.

POSTING, SECURITY AND CONTROL OF AREAS WHERE ONLY SEALED SOURCES ARE PRESENT

GENERAL

Sealed sources are a special program within MU's RSP. These sources are permanently encapsulated in a solid form with an inert covering, so as to preclude their leakage and/or dispersal to the environment under normal circumstances. These types of sources also include foils, where the radioactive material is permanently bound to a metal substrate. In both cases the manufacturing process is performed and controlled under a license issued to the manufacturer specifically for the production and distribution of these products. These sources are used for the radiation they emit, rather than for the radioactive material itself.

LEAK TESTS AND INVENTORY

MU's NRC License requires these sources to be leak tested at prescribed intervals. The license also requires that all locations of storage and use must be approved by the RSC.

Inventory, radiation level measurements, and leak tests are performed, and documented by the RSS during quarterly inspections. This inventory meets the requirement for the authorization's Quarterly Report. AU's are responsible for assuring that the sources remain secure and that their use controlled. The source(s), apparatus, or inventory/use log may be required to have a documented monthly review/inventory to assure control. Radiation dose measurements may or may not be required for the monthly documented review, depending on the nature and use of the source(s). The monthly requirements for user documentation will be issued as a specific authorization condition.

POSTING

Sealed source storage containers, cabinets, exposure devices, equipment containing sealed sources and, if appropriate, transport containers must be posted with "CAUTION RADIOACTIVE MATERIALS".

Posting of a room entrance or area is not required when the radiation level at 30 centimeters from the source container or housing do not exceed 5 mrem/hr [10 CFR 20.1903 (c)]. Most rooms or areas in which sealed sources are stored at MU do not require posting.

Rooms or areas where the dose rate at 30 centimeters exceeds 5 mrem/hr must be posted at the entrance with "CAUTION RADIOACTIVE MATERIALS" and with "RESTRICTED AREA" signs. However, by definition, the radioactive material is not in an "un-contained" form, therefore, there is no requirement for the "NO EATING, DRINKING OR SMOKING" posting. Additionally the NRC Form 3 and Radiation Emergency Procedures are required to be posted in the storage, or use room.

SECURITY

Emergency and DOT transport procedures are required to be with the source transport packaging and manifest during field operations. Direct RW supervision must be maintained during all field operations when the source is not secured under lock and key.

HOW TO MINIMIZE YOUR EFFORT AND MAINTAIN A USABLE LAB WITH GOOD RADIATION SAFETY

GENERAL

Radiation safety does not have to be a burden. Remember that you can break down the RSP requirements into six basic areas:

- Radioactive material receipt,
- Inventory,
- Use,
- Disposal,
- Personnel training, and
- Surveys.

Keep your work area neat and organized. Label any equipment which is known to be or may potentially become contaminated. In lieu of labeling, keep all contaminated equipment together in area which is clearly designated for radioactive material use.

Make sure waste material and any contaminated laboratory equipment is properly shielded to minimize any unnecessary exposure to your fellow workers. Be sure you periodically survey your waste areas to check for high exposure levels and spill of radioactive material.

RECORDS

Keep accurate records of your material receipt and usage. Note any transfers in or out, and keep records of your waste disposal, including non-radioactive chemical constituents.

TRAINING

Make sure your personnel's training is up to date. It is recommended that all RW's have continuing radiation safety training each year. The RS Office provides many different opportunities for training throughout the year.

SURVEYS

Monitoring must be conducted after each use of uncontained radioactive material and in the case of spills and decontamination. Hands, shoes, floor, work area, etc. must be monitored after each use of radioactive material. Documented surveys must be done at the specified intervals based on activity of the radioactive material handled. Remember to do both swipes and meter surveys. Swipes are valuable in assessing removable contamination. See Procedures for Surveys for specific requirements.

OBTAINING A REQUEST FOR APPROVAL TO ORDER RADIOACTIVE MATERIAL

PURPOSE AND CONDITIONS

This procedure applies to all radioactive materials purchased with any MU funds that will be ordered and received under MU's license.

Each request for approval to order radioactive material must be reviewed and approved by EHS to ensure that the AU is approved to purchase radioactive material.

All radioactive material must be delivered to EHS unless a special condition is approved and included in your authorization.

COMPLETING A REQUEST FOR APPROVAL TO ORDER RADIOACTIVE MATERIAL

Fill out the MU "Request for Approval to Order Radioactive Material" form.

JOB/ORDER NUMBER AND ORDERING

Bring or send the completed and signed "Request for Approval to Order Radioactive Material" form to EHS for review and signature approval.

NOTIFICATION OF RADIOACTIVE MATERIAL ORDER

PURPOSE

Once you have placed an order for radioactive material, the RS Office must be notified of the order to ensure same day delivery to the lab following receipt at EHS. Same day delivery cannot be ensured if the notification is received after 8:00 am on the day of delivery. To notify the RS Office of a radioactive material order, complete the online "Isotope Request/Transfer" form or fax a completed copy of the "Notification of Radioactive Material Order", form the same day that the order is placed.

HOW TO COMPLETE THE NOTIFICATION FORM

Current versions of this form are available at http://ehs.missouri.edu.

Complete the date the order is placed.

Print the name and Authorization Number of the AU that will be receiving the radioactive material.

Print the full name of the vendor supplying the radioactive material.

Print the date that the radioactive material is scheduled to be delivered to the Research Park Development Building #8. Please use separate Notification Forms for different delivery dates.

Print the building and room number where Radiation Safety is to deliver the radioactive material. Please note that the delivery location must be an approved location under the authorization.

For each material ordered, list the radionuclide, chemical form, physical form, and activity ordered in mCi. List each ordered item separately. Delivery of the radioactive material will be delayed if the order amount plus the current possession exceed the authorization limit for that radionuclide.

Print the name of the person placing the order and their telephone number as a contact for the RS Office. This person should be knowledgeable of the order and able to answer questions about the notification.

Here are some suggestions on using the order form:

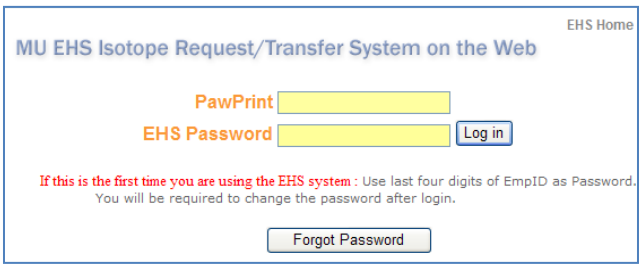
- If you have a routine scheduled receipt of radioactive material, please contact your assigned HP to determine if a notification will be necessary for each order.
- If you order the same material from the same vendor or the same person orders every time, set up a standard order notification so that you only have to fill in the items that change each time.

ISOTOPE RECEIPT/TRANSFER FORM ONLINE

This form is available at:

http://ehs.missouri.edu/webapp/isotopereqxfer.html

Initial access to the system will require the AU's Pawprint and the last four digits of the AU's employee identification number as the password. The AU will be prompted to create a unique password for future login.



Notification of Radioactive Material Order

EHS Fax No.: 573- 882-7940

(Type or Print Clearly)

Date Ordered: ____ /____ /____ (Please fax to MU EHS the same day the order is placed to assure prompt delivery)

Authorized User Name: _____ Auth. No.:_____
(Please print)

Vendor: _____
(Please print)

Date Scheduled for Delivery: _____ /_____ /_____ Job/ Order No.: _____
(Please use separate notification form for different delivery dates)

Delivery Location -- Building: _____ Room: _____
(Please note that delivery location must be an approved area under the Authorization)

Isotope(s) Ordered (For each chemical form)	Physical and Chemical Form	Activity Ordered (mCi) (For each chemical form)
1.		
2.		
3.		
4.		
5.		

(Please note that delivery will be delayed if order amount plus current possession exceeds authorization limit)

Contact Person: _____ Telephone No.: _____
(Please print)

HOW TO TRANSFER POSSESSION OF RADIOACTIVE MATERIAL

RESPONSIBILITIES

When transfers of radioactive materials to or from other AU's are anticipated, the AU's involved should be listed on the application for authorization, along with the isotope(s) and activity(s) limit per transfer, and an estimate of the total activity per year to be transferred.

EHS must be notified with the necessary information about the transfer, prior to the transfer of radioactive material, and that all the requirements for transferring radioactive material is documented.

TRANSFERRING RADIOACTIVE MATERIAL BETWEEN AUTHORIZED USERS

Authorization Transferring Material

Verify that the user receiving the material is authorized for the isotope and activity to be transferred.

Individual laboratories can NOT transfer radioactive material in any vehicle (personal or MU or other), unless specifically trained and approved by EHS.

Radioactive material to be transferred must be packaged to minimize external dose rates and to ensure that the material is well contained, including double containment for liquids. Ensure that it is free from external contamination (200 dpm/100 cm^2).
Contact your assigned HP for packaging, marking and labeling instructions.

The above items must be documented for all transfers of radioactive material.

The following information must be included:

- A contact person (name and phone),
- The transferring and receiving AU's (names, numbers, and locations),
- Isotope,
- Activity,
- Inventory number,

The following information must be included:

- Transfer date,
- Verification that the packaging, labeling, contamination requirements have been met,
- Verification that the receiving AU's authorization limit has not been exceeded by receiving the transfer (which includes the amount on-hand, including waste that has not been transferred to EHS, plus the amount of the transfer).

Authorization Receiving Transfers

Notice of ALL transfers of radioactive materials must be completed by the receiving AU and submitted using the online "Isotope Request/Transfer form or faxed to EHS using the "Notification of Radioactive Material Transfer" form.

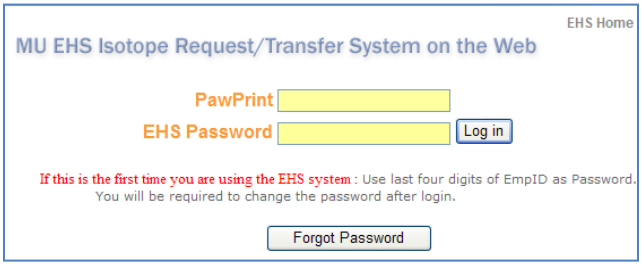
Retain the confirmation email that your online request was received or keep a copy of the faxed "Notification of Radioactive Material Transfer" for your records and inspection purposes.

ISOTOPE RECEIPT/TRANSFER FORM ONLINE

The online Isotope Request/Transfer form is available at:

http://ehs.missouri.edu/webapp/isotopereqxfer.html

Initial access to the system will require the AU's Pawprint and the last four digits of the AU's employee identification number as the password. The AU will be prompted to create a unique password for future login.



TRANSFERRING RADIOACTIVE MATERIAL BY VEHICLE OR OFF CAMPUS

Offering radioactive materials for transport by commercial carrier (Federal Express, private courier, etc.) is PROHIBITTED. Transportation of radioactive materials by vehicle is PROHIBITED except for exempt quantities or NORM. (Non-inventoried material with RS approval)

All radioactive material transport must be conducted through EHS - contact you're assigned HP.

For all off campus transfers and on campus transfers by vehicle, the transferring AU must contact their assigned HP to arrange for RSS pickup and shipment of the material. RSS will ensure the material is properly classified, marked, labeled and packaged for transport.

Notification of Radioactive Material Transfer

EHS Fax No.: 573-882-7940
(Please fax to MU EHS before the transfer takes place)

Date Transferred: _____/_____/_____

FROM Authorized User Name:

Auth. No.: _____ Location: _____
(Please print) (Room & Building)

TO Authorized User Name:

Auth. No.: _____ Location: _____
(Please print) (Room & Building)

Requirements -- Authorized Users must be authorized for the isotope and amount being transferred. Notice of ALL transfers of radioactive materials must be faxed to EHS by the receiving Authorization. Transfer cannot involve transport with any vehicle (contact assigned HP if vehicle is needed).

Isotope(s) Transferred	**Inventory Number** (if known)	**Activity Transferred (mCi)** (Decayed to Date of Transfer)	**Is Authorization Limit Exceeded?** (Circle yes or no)	**Package Labeled and No External Contamination**
1.			yes no	
2.			yes no	
3.			yes no	

(Note that transfer amount plus current possession cannot exceed the authorizations limit)

Contact Person: _____

Receiving Auth. No.: _____ Telephone No.:_____
(Please print)

MOVING OUT OF OR INACTIVATING AN APPROVED AREA

GENERAL INFORMATION

When moving out of an approved area, you are responsible for notifying the RSS before moving out, for ensuring proper transfer or disposal of all radioactive materials, and for decontaminating any remaining contaminated area or equipment. This procedure provides the steps needed to meet these responsibilities.

Use This Procedure When You Are;

- Assigned a different area -- remember you must be approved to use radioactive materials in any new area before you move radioactive materials into any area (Radioactive Material Location Page),
- Inactivating an area or total authorization (How and When to Complete Authorization Application),
- Renovating your use area and then moving back in,
- Terminating authorization.

What To Do Before You Move Out;

Call you assigned HP to discuss reason for move and discuss a time schedule, please give as much advance notice as possible. When the work has been completed with radioactive material in your approved area arrange for a radioactive waste pickup and have it completed prior to pickup (Requesting Pickup of Radwaste) and remove any remaining radioactive material or contaminated equipment by;

- Moving it to another of your authorized areas (Contact your assigned HP if the move must be done by vehicle),
- Transferring it to another MU AU (How to Transfer Possession of Radioactive Material),
- Arranging with your assigned HP to have it shipped off license.

Thoroughly survey the room and labeled equipment, and decontaminate contaminated items (Procedures for Surveys).

Arrange with assigned HP for closeout/ decommissioning survey.

Previously labeled equipment like refrigerators, centrifuges, liquid scintillation counters, ovens, pipettes, etc. must be surveyed and de-labeled by the RSS before releasing them for unrestricted use.

The room must be surveyed and deposted by the RSS before it is released for unrestricted use.

Do not allow anyone to move in or start any other work in the room or on the equipment before the RSS deposts the room or de-labels the equipment.

CHANGE IN AUTHORIZATION

Authorization is changed to remove room; room or total authorization inactivated, or authorization is terminated.

To reactivate room or authorization, contact your assigned HP.

REQUESTING PICKUP OF RADWASTE

PREPARATION OF RADWASTE AND RECORDS

Segregation

Segregate all radwaste into the following forms: Solids, Liquids, Stock, Scintillation Vials, Gases, Animal Carcasses or Tissue(s), and Animal Waste. These forms then need to be further segregated according to isotope and other hazardous material components. Label all containers that have an EHS "Radioactive Hazardous Material" label with this information.

For liquid radwaste, a sample aliquot measurement of the activity may provide the easiest and most accurate estimate of the overall activity. A composite sample may be used for multiple gallon jugs of the same isotope and hazard class. Be sure to list the activity as of the date of request.

Keep unwanted stock containers separate for pickup. Containers with lead shielding must not be disposed of in normal trash, but must be returned to EHS for disposal or recycling.

See Collection of Radwaste in Your Laboratory for further details.

Records

Calculate all activities to the date of the requested pickup. Ensure to date on bottom of form.

Review activity balances for receipts, samples, and different radwaste types to ensure all incoming activity has been accounted for.

REQUESTING AND OBTAINING RADWASTE PICKUP

Request Form

Complete a Radwaste Pickup Request Form (PURF) as follows:

- Date of request,
- AU name,
- AU number,
- Registered user number,
- Person requesting pickup,
- Telephone number,
- Building and room of pickup.

Each container or item must have its own “Radioactive Hazardous Material” label and be listed separately on the PURF.

Different physical forms of radwaste must be packaged and listed separately.

Mark the appropriate physical form box and provide the quantity in the listed units.

List the percent (%) by volume of each chemical component (estimate as necessary) for each pickup item.

Materials listed on the "Radioactive Hazardous Material" label must match the components listed on the form.

Liquids must have a pH greater than 5.5 and less than 9.5. If the pH is not within this range, adjust the pH with an appropriate acid or base. Any addition of acid or base used to adjust the pH must also be listed as a component on the label and on the form.

List the isotope and activity in milliCuries (decayed or measured as of date of request).

Non-contaminated empty lead pigs can be added to the Radwaste Pickup Request Form.

If more bags or jugs are required, you can write your request at the bottom of the form.

Do not write in any other columns of the form.

Contact your assigned HP if you have any questions.

Requesting a Pickup

Fax the completed PURF to the RS Office (882-7940) and note any special instruction.

Alternatively you can complete an online PURF available at:

https://secureas.missouri.edu/EHS/purf/purf_login.cfm

Instructions for the online PURF are also available:

http://ehs.missouri.edu/haz/forms/webpurf-rad-instructions.pdf

Routine pick-up routes have been established for some areas of campus. Request forms must be received before 8:00 am on the scheduled pickup day to have your radwaste considered for pickup that day.

EHS will try to complete requested pickups as soon as possible, and will alert the AU if pickup cannot be done within two weeks of the request.

If information is incomplete on the form, or is not clearly printed, or if there is a question about the request, processing of the request may be delayed.

Pickup of Radwaste

At time of pickup, someone in your area must be available to allow access to your radwaste, answer any questions concerning the radwaste, and correct any problems.

If you cannot be in the immediate area, leave a note to alert EHS staff how to locate you. If you cannot be reached within 15 minutes, your radwaste may not be picked up on that day.

If your request form is not complete, is incorrect, or there is a problem with the form or hazard of your radwaste, your pickup may be delayed until the corrections have been made.

Inventory Records

Update your records to reflect that the activity of the radwaste, which was removed from your lab, is no longer possessed under your authorization.

Special Needs

Contact your assigned HP for any special radwaste handling needs or questions.

University of Missouri-Columbia
Radioactive Materials Pick Up Request Form

MU Environmental Health and Safety
Fax: 882-7940

Date of Request ________ Authorized User ________ Authorized User Number ________ Registered User Number ________

Person Requesting Pick Up ________ Telephone ________ Building ________ Room ________ Other ________

Each physical form must be in separate containers – DO NOT MIX

Physical Form Abbreviations: A = animal (in kg) G = gas (in ft³) L = liquid (in gal) S = solid (in ft³) STO = stock (in gal) V = vials (in gal)

NOTE: Please ** any chelating agents that are greater than 0.1% weight

RS PU #	Authorized User: Complete these columns only					Act (MBq)	Cont. ID#	Destination			HWD	ROUTING
	Qty	Physical Form & Unit (check one)	Type of Material (Components & Concentrations)	Isotope	Activity (mCi)			R R C	R W B	S F	Acq. Date	Document #
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										
		☐ A (kg) ☐ S (ft³) ☐ G (ft³) ☐ STO (gal) ☐ L (gal) ☐ V (gal)										

I hereby certify that the above information is correct and that the activities have been decayed to the date of the Pick Up Request.

________________________ ________________
Authorized User or Designated Representative Date

Rev 9/1/99

HOW TO COMPLETE YOUR QUARTERLY REPORT

GENERAL

Quarterly reports cover a calendar quarter, starting on January 1st of each year with subsequent quarters beginning on April 1st, July 1st, and October 1st. These are used by the RS Office to verify receipt, transfers, disposals and decay of your isotopes in order to meet our commitment of inventory control for the NRC. Below are some of the areas in the report you should examine to ensure that our records match yours.

The general information includes the AU's name and campus address, AU's number, survey class, e-mail address, authorization expiration date, office and lab phone numbers, assigned HP initials and RSC Representative.

Authorized Areas; lists rooms covered under the authorization.

Authorization Data; lists the isotopes, units, forms, and quantities authorized for order and possession. Any special conditions pertinent to the authorization are listed here, such as restricted area modifications, co-authorizations, etc.

Isotope Inventory Changes for the Quarter; Isotopes, including sealed sources, are listed alphabetically with units in milliCuries. The quarter is summarized by

- Starting possession,
- Total receipts,
- Total transfers in,
- Total transfers out,
- Total waste,
- Total adjustments,
- Current possession.

All numbers for the above columns are decayed to the last date of the quarter for calculation purposes.

Isotope Receipt from Other Licenses; list of all receipts from other licenses.

Isotope Receipt from MU Transfers; list by transfer date and reference who transferred the material to you.

Isotope Transfers out from Authorization; transfer transactions listed by date, isotope, and to whom transfer was to.

Isotope Waste Pickups; lists the date that the waste was requested to be picked up and actually was picked up, the isotope, its form (solid, liquid, vials, etc.), requested date activity, and activity at the end of the quarter.

Isotope adjustments made by Radiation Safety Staff; lists any adjustments made to reconcile your inventory records with ours, if necessary. Contact your assigned HP if you have any questions regarding this column.

Sealed Sources Isotope List; lists all sealed sources with the internal (RS) inventory number, quantity on hand, type of inspection performed (leak test and/or inventory) and the last leak test date.

Worker (as of date of report); lists current RW's by name, employee ID or student number, Form 3 date (Training and Experience Form), last formal training program description, last formal training date, and the (tentative) date of the next training update. You should examine each column and then make any appropriate corrections as noted in the Check off Box area. You should also write in the information that you wish to be changed in the appropriate area.

Instruments (as of date of report); list of all survey and counting instruments which are registered for particular authorization and calibrated by the RS Office. Check to ensure that all instruments are accounted for, that the serial numbers are correct, and that the calibrations are current. Make corrections as necessary on quarterly report.

Name and Signature; space is provided for the preparer of the report to sign and date the quarterly report form. Once completed, the form should be given to the AU's for their review and signature if they were not the preparer.

Once the report is completed, make a copy for your records and return the original to your assigned HP.

PROCEDURES FOR DEVELOPING, MAINTAINING, AND IMPLEMENTING WRITTEN DIRECTIVES

(Authorized Users for Medical Use)

USE OF RADIOPHARMACEUTICALS

The following are policies and procedures to be followed in the administration to patients of therapeutic radiopharmaceuticals or dosages of I-131 (Sodium Iodide) over 30 microcuries. If the person assigned to do any or all of the preparation and/or administration of radiopharmaceuticals does not understand any portion of a written directive, or a diagnostic procedure as approved by an authorized nuclear medicine physician, they are to stop and ask sufficient questions to adequately clarify the radiopharmaceutical, dose, route of administration, patient identity, and any related details before proceeding with the procedure.

Written Directives for Therapeutic Radio-pharmaceuticals, and Dosages of I-131 Sodium Iodide over 30 microCuries

A written directive must contain the patient's name, radiopharmaceutical, dosage and route of administration and shall be signed and dated by an authorized nuclear medicine physician prior to preparation or administration of any therapeutic radiopharmaceutical, or dosage of I-131 Sodium Iodide over 30 microcuries.

Procedures for emergency oral directives (approved nuclear medicine consult), and written revision(s) to an existing written directives are given in 10 CFR 35.40(a)(1).

Copies of the written directives shall be retained for a period of three years after the date of administration, as set forth in 10 CFR 35.2040.

Patient Identification

Prior to administering the radiopharmaceutical, the person who is to administer the radiopharmaceutical will positively verify the identity of the patient or human research subject as the individual named in the written directive. Examples of positive patient identity verification include examining the patient ID bracelet, hospital ID card, driver's license, or social security card.

Verification of Dose Prior to Administration

Prior to administering the radiopharmaceutical, the person who will do the administration is to verify that the details of the administration are in accordance with the written directive (or approved nuclear medicine consult). In addition to verifying the patient's identity, the radiopharmaceutical, dosage (activity), and the route of administration are to be verified to be in agreement with the written directive, or with the oral revision made by the authorized nuclear medicine physician's [written directive or revision of written directive must be obtained in accordance with 10 CFR 35.40(a)(1)]. The radiopharmaceutical activity is to be measured in a dose calibrator, and the results recorded and compared to the written directive.

Documentation of Administered Dose

The authorized physician, or a qualified individual under supervision of an authorized physician (nuclear medicine physician, physicist or technologist), shall make a record of the administration. The record will include the date, patient's name, radiopharmaceutical dosage, and signature or initials of the person administering the dose. The administration record is included on the same form with the written directive, and is available for audit. This form will include the following statement, or equivalent: "Retain record for three years following administration, as required by 10 CFR 35.2040."

BRACHYTHERAPY PROCEDURES

The following are policies and procedures to be followed in the use of radiation from brachytherapy sources for patient procedures. The use of sealed radioactive sources for brachytherapy procedures may involve one or more qualified persons (radiation therapy physicist, radiation therapy technologist, dosimetrist, oncology physician) working under the supervision of an authorized physician. Prior to the delivery of radiation from any brachytherapy source to a patient, there must be a written directive, see paragraph below. If at any point a supervised worker does not understand how to carry out the written directive, they are to stop and ask sufficient questions to clarify the procedures described in the written directive.

Written Directives

Prior to any administration of radiation from brachytherapy sources, an authorized physician will sign and date a written directive, and a treatment plan for the procedure. The written directive will include the patient's name, and before implantation: treatment site, the radionuclide, and dose to be delivered to the target area. After implantation but before completion of the procedure the written directive will include: the radionuclide, treatment site, number of sources, and total source strength, and exposure time (or the total dose). Procedures for emergency oral directives and revisions to written directives are given in 10 CFR 35.40(c).

Records of written directives and administration of each administered dose will be retained for a period of three years after the date of administration, as set forth in 10 CFR 35.2040.

Patient Identification

Prior to administering a brachytherapy dose, the patient's or human research subject's identity will be positively verified as the individual named in the written directive. Examples of positive patient identity verification include examining the patient ID bracelet, hospital ID card, driver's license, or social security card.

Verification of Brachytherapy Plan of Administration

Before brachytherapy radioactive sources are administered, a qualified person such as a radiation therapy physicist, oncology physician, dosimetrist, or radiation therapy technologist, working under the supervision of an authorized physician will verify that the radioisotope, number of sources, and source strengths of the brachytherapy sources described in the plan of treatment are in agreement with the written directive. The person verifying agreement between the plan of treatment and the written directive will sign or initial and date the plan of treatment.

Checking Brachytherapy Dose Calculations

Before the total prescribed brachytherapy dose has been administered, an authorized physician or a qualified person such as a radiation therapy physicist, oncology physician, dosimetrist, or radiation therapy technologist, under the supervision of an authorized physician, will check the dose calculations for the brachytherapy procedure. Whenever possible, this will not be the same person who made the original calculations. Manual dose calculations will be checked for

- Arithmetic errors;
- Appropriate transfer of data from the written directive, plan of treatment, tables, and graphs;
- Appropriate use of nomograms;
- Appropriate use of all pertinent data in the calculations.

If available, printouts from computer-generated dose calculations will be checked to verify that the correct data was used in the calculations, including position of the applicator or sealed sources, isotope, number of sources, total source strength, or source loading sequence. Checking may also be done by using manual calculations of a radiation dose to a single key point, with comparison to the computer generated dose calculations. In the cases where radiation doses are calculated during a combination of computer generated output and manual calculation, verifying will include checking that the correct output from one type of calculation is properly used as the input for the other type of calculation.

Verification of Brachytherapy Source Administration

Prior to administering brachytherapy sources, a qualified person, such as a radiation therapy physicist, oncology physician, dosimetrist, or radiation therapy technologist, under the supervision of an authorized physician will verify that the radioisotopes, number of sources, source strengths, and if applicable, loading sequence of the sources to be used are in agreement with the written directive and plan of treatment. The verification method will be appropriate to the sources used, and may include checking the serial number of sealed sources behind an appropriate shield, using a dose calibrator, observing color codes on the sources, monitoring radiation output of the sources with a radiation detector, or using clearly marked storage locations where separate storage areas are used for different source strengths.

Temporary Brachytherapy Source Position and Exposure Time Verification

For temporary brachytherapy implants, the position of the sources will be verified using x-ray imaging procedures. When possible, the x-ray imaging will be done with "dummy" sources before the radioactive sources are inserted. These x-ray images of source position will be used to calculate the exposure time needed to achieve the prescribed radiation doses, or to calculate the total dose. In the cases where fixed geometry applicators, appliances or templates are used to calculate an exposure time or total dose, x-ray imaging of the source positions is not mandatory. Immediately after implanting sources in the patient, survey of the patient and the surrounding area will be made to confirm no sources are unintentionally misplaced outside of the patient.

Recording Application of Temporary Brachytherapy Implant Sources

After insertion of temporary implant brachytherapy sources, an authorized physician will promptly record the radionuclide, treatment site, number of sources, and total source strength, and exposure time (or the total dose). This form will be in the patient's chart or other appropriate record, and will be signed or initialed by the authorized physician. This form will include the following statement, or equivalent: "Retain record for three years following administration, as required by 10 CFR 35.2040."

Permanent Brachytherapy Source Position and Total Dose Verification

For permanent brachytherapy implants, x-ray imaging of the sources in place will be performed as a basis for verifying the position of the source and calculating the total dose. If applicable, this x-ray imaging will be done after inserting the sources into the patient. In cases where fixed geometry applicators or templates are used, x-ray imaging of the source positions in the patient is not mandatory. Immediately after implanting sources in the patient, survey of the patient and the surrounding area will be made to confirm no sources are unintentionally located outside of the patient.

Recording Application of Permanent Brachytherapy Implant Sources

After insertion of permanent implant brachytherapy sources, an authorized physician will promptly record the radionuclide, treatment site, number of sources, and total source strength. This form will be in the patient's chart or other appropriate record, and will be signed or initialed by the authorized physician. This form will include the following statement, or equivalent: "Retain record for three years following administration, as required by 10 CFR 35.2040"

Brachytherapy for Emergency Medical Conditions

If an authorized physician determines that delaying brachytherapy treatment in order to perform the checks of dose calculations would jeopardize the patient's health because of the emergent nature of the patient's medical condition, the checks of the calculations will be performed within two working days of completion of the brachytherapy treatment.

Acceptance Testing of Brachytherapy Dose Planning Computer Programs

Before the first use of treatment planning or dose calculating computer programs for brachytherapy dose calculations, acceptance testing of the programs will be performed by a qualified person. The functions of the computer programs evaluated during acceptance testing will include the dose and spatial accuracy of calculations in tissue for at least those brachytherapy procedures clinically

performed by authorized physicians under this license.

PERIODIC REVIEW OF MEDICAL USES OF BYPRODUCT MATERIALS

In accordance with 10 CFR 35.41 we will develop, implement, and maintain procedures to conduct periodic reviews of each applicable program area, e.g., radiopharmaceutical therapy and implant brachytherapy. The number of patient cases to be sampled will be based on the principles of statistical acceptance sampling and will represent each treatment modality performed in the institution, e.g., radiopharmaceutical and brachytherapy.

These reviews will be performed by a HP, medical physicist, or other qualified person. If possible, the persons conducting the review will not review their own work. The findings of the periodic reviews will be reported at the meetings of the Medical Quorum of the RSC to ensure that the procedures for administrations requiring a written directive are effective.

A determination will be made as to whether the administered radiopharmaceutical dosage or radiation dose was in accordance with the written directive or treatment plan, as applicable. For each patient case reviewed, deviations from the written directive, the cause of each deviation, and the action required to prevent recurrence will be identified.

RECORDS FOR PROCEDURES FOR ADMINISTRATIONS REQUIRING A WRITTEN DIRECTIVE

A copy of the procedures for administrations requiring a written directive shall be retained for the duration of the license.

REPORTS OF MEDICAL EVENTS

The RSO will notify the NRC Operations Center no later than the next calendar day after discovery of the medical event and submit a written report to the appropriate NRC Regional Office listed in 10 CFR 30.6 within 15 days after the discovery of the medical event, as required by 10 CFR 35 3045. The RSO will also notify the referring physician and the patient as required by 10 CFR 35.3045.

CORRECTIVE ACTION REVIEW FOR AUTHORIZATION DEFICIENCIES

GENERAL

During the course of authorization inspections the RSS sometimes finds conditions which may not be in full compliance with NRC regulations, NRC license conditions, or MU policies and procedures. If these are not routine or reoccurring situations they are usually corrected during or shortly thereafter the inspection and do not present further problems.

In the case these same problems reoccur inspection after inspection, or disappear for a while and then periodically reoccur, a more aggressive approach needs to take place to find the cause of the problem(s), rectify the situation, and take measures to ensure that these conditions do not occur again in the future.

REVIEW AND ASSESSMENT

Conduct a complete and thorough review of the circumstances that led to the deficiency. Talk to the personnel involved, review relevant procedures for completeness or need for revisions, and review the training of those involved to see if a lack of training may have contributed to the problem.

IDENTIFICATION

Identify the root cause of the deficiency. Identify the direct and indirect causes which may have led to the problem.

CORRECTIVE ACTIONS

Take prompt and comprehensive corrective action that will address the immediate concerns and prevent reoccurrence of the deficiency. Examples of areas to examine include:

- Is training of individual lab workers adequate?
- Are lab surveys frequent enough and do they examine the right areas?
- Are the material use and safety procedures adequate and up to date?
- Do you maintain a dialog with the RSS if you have any questions concerning changing requirements?
- Does the AU disseminate information regarding radiation safety issues to the laboratory staff and vice versa?
- Does the laboratory staff have the opportunity to suggest improvements and assist in making the radiation safety program workable and more streamlined to meet the needs of your specific laboratory?
- Are there specific disciplinary policies for safety violations?

Follow up to determine if appropriate corrective actions are being taken and if they are effective.

LOSS OF CONTROL

If an Authorized User (AU) identifies an issue that presents a significant risk to human health and safety or to the license; the AU is strongly encouraged to self-report such findings to the RSO. The Radiation Safety Committee intends there to be a self-reporting infrastructure so that a healthy 'radiation safety culture' will prevail.

The RSO is bound to maintaining a safe environment and is authorized to seize radionuclides and/or locations in order to place an authorization in a safe condition in the event the AU cannot. These roles and responsibilities of the RSO are identified in the Universities NRC license. The Radiation Safety Committee will work in concert with the RSO to resolve any such issues. An "A" deficiency will be assigned only after a full Radiation Safety Committee meeting.

Events that could result in an "A" deficiency are outlined in the **ENFORCEMENT PROCEDURES** section.

RADIATION WORKER

RESPONSIBILITIES

TRAINING AND PERFORMANCE-BASED EVALUATIONS

Participate in radiation safety training appropriate for your work situation.

Learn about potential hazards of radiation and radioactive material associated with your work and work area; know where information on the radioactive material is kept for your review; and use this information when needed.

Seek help from the AU or the RSS if you are unable to fulfill your responsibilities due to lack of training or understanding.

Understand and follow authorization-specific procedures and established ALARA levels.

MATERIAL CONTROL

Ensure exposure to all individuals from radioactive materials and radiation is As Low As Reasonably Achievable (ALARA).

Use engineering controls (e.g., fume hoods, shielding, etc.) and personal protective equipment appropriate for your work.

Maintain security of radioactive materials from access by unauthorized individuals.

Ensure inventory and related records are maintained appropriately.

ASSESSMENT AND CORRECTION

Notify other authorized personnel of unusual circumstances.

Stop work if you reasonably believe continuation of the work poses an imminent danger to the health and safety of the lab personnel or public, and immediately notify your supervising RW or AU.

Report all unsafe conditions to your supervising RW, AU, Administration, RSS, Radiation Safety Committee, or the NRC.

Participate in the required Review and Assessment and the Corrective Action Program as established in the authorization-specific procedures and implement corrective actions to prevent reoccurrence.

WHAT MUST BE DONE

TRAINING AND PERFORMANCE-BASED EVALUATIONS

Learn safe operating and emergency procedures appropriate for your work.

Follow procedures and observe precautions for the use of radioactive materials, as detailed in the approved authorization and in the RSM.

Periodically update your radiation safety training.

MATERIAL CONTROL

Carry out established authorization-specific procedures to be in compliance with MU Radiation Safety Program procedures.

Survey yourself each time before you leave your work area or touch areas not allowed to be contaminated.

Survey yourself and surrounding areas after you finish working with radioactive material.

Return stock to proper storage and record activity (or volume and activity conversion) removed.

Record estimated activities (or volume and activity conversion) going to samples, liquid waste, and solid waste to document location of radioactive material at any time.

Be able to determine activity in stock, samples, liquid waste, and solid waste at any time (this is necessary when waste is prepared for pickup).

ASSESSMENT / CORRECTION

Document any contamination you find upon surveying, actions taken, and final dose rates or levels of contamination following the decontamination efforts.

Alert, notify or warn co-workers about defective equipment and radiation hazards.

Periodically review corrective actions and ensure implementation.

PROCEDURES

10 CFR PART 19 REPORTING REQUIREMENTS
"NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS"

PURPOSE

Part 19 of Title 10 CFR (Code of Federal Regulations) spells out certain requirements which licensees must meet to inform workers of hazards or potential hazards associated with the use of radioactive materials, and to inform these workers of their rights in reporting suspected or real problems related to the safe use of radioactive materials.

POSTING

MU is required to post or make available certain documents to the radiation worker. These documents include the NRC license and its associated documentation, regulations in 10 CFR Part 19 and 20, any applicable operating procedures related to the license, and any notice of violations related to the license. The documents can be reviewed in the RS Office, Research Park Development Building #8, during normal working hours, 8 a.m. - 5 p.m., Monday - Friday. The Code of Federal Regulations can be viewed on line.

TRAINING

Persons who are likely to receive 100 mrem in a year must be kept informed of the storage, transfer and use of radiation and radioactive materials, and in the health risks associated with exposures to radiation or to radioactive materials.

Workers must be instructed in, and required to observe the regulations and license conditions related to the protection of personnel from exposure to radiation.

Workers must be aware of their responsibility to report unsafe conditions which may cause violations of NRC regulations or license conditions to the AU, the RS Office or the NRC.

Workers must be made aware of the reports available to them as a result of being monitored for radiation exposure; including the annual report given to workers who are currently monitored here, at MU, and the report available to the worker upon termination of employment, if it is requested by the worker.

RIGHTS AND RESPONSIBILITIES

Workers may meet in private with representatives of the NRC during an inspection or may request to have a representative present during an inspection. The University of Missouri may also have representatives present during inspections, provided that they do not interfere with the conduct of the inspection.

Workers may bring to the attention of the NRC any violations or suspected violations of NRC rules and regulations and request an inspection of the licensee. The request for inspection must be in writing.

No employee may be discriminated against for bringing safety related concerns to the attention of the NRC.

GOOD LABORATORY PRACTICES WHEN WORKING WITH RADIOACTIVE MATERIALS

PROTECTIVE CLOTHING

Gloves: Disposable gloves shall be worn when handling radioactive materials in an uncontained form and when handling any item in the radiation work area. Contaminated gloves shall be removed and deposited in a radioactive waste receptacle before leaving the radioisotope work area.

Lab Coats: Laboratory coats (or similar protective clothing) shall be worn when handling radioisotopes in an uncontained form. If shorts or a dress are being worn, then knee-length or longer laboratory coats (or similar protective clothing) shall be worn when handling radioisotopes in an uncontained form.

Laboratory coats (or similar protective clothing) worn in potentially contaminated areas shall not be worn in non-radioactive areas, unless surveyed and found to be not contaminated.

Shoes: Closed-toed shoes shall be worn when handling radioisotopes in an uncontained form.

Survey: All protective clothing, including hands and feet, must be surveyed prior to leaving the radiation work area.

SHIELDS AND PROTECTIVE DEVICES

Gamma Emitters: Lead or similar high-density shielding is required for routine handling of quantities greater than 1 milliCurie of gamma emitters.

Syringes: Shielded syringes are to be used when activities of greater than 1 milliCurie gamma emitters are used in hand held syringes.

High Energy Betas: Plastic or other low-density shielding is required when using more than 5 milliCurie of a high energy beta emitter such as P-32.

Waste: Shields may be required for radioactive waste storage as well as for the work area to maintain ALARA doses.

LABELING OF ITEMS & EQUIPMENT

Items: Small items, such as pipettes, syringes, pens, etc., should be individually labeled as contaminated. Or, the items should be confined to a well defined and labeled area which indicates that any items in that area are contaminated or have the potential to be contaminated.

Equipment: Equipment such as centrifuges, refrigerator/freezers, fume hoods, etc., should be labeled when the use of these items could lead to internal contamination. Labeling, along with appropriate training of all personnel, will preclude spreading of contamination by multiple users of this equipment.

PROCEDURES FOR SURVEYS

REQUIREMENTS

AU's shall be responsible for ensuring that both monitoring during use and after use are performed with each use of radioactive materials. The type of monitoring and surveys shall be appropriate for detecting the isotope in use; and the area covered shall be sufficient to assure that radioactive material remains controlled and within the radioisotope work or storage area.

All surveys shall include

- Measurement of surface contamination with the appropriate instrument,
- Measurement of removable contamination by swipes.

WHEN TO DOCUMENT A SURVEY

Although routine surveys shall be performed during and after every use of radioactive materials, not all surveys need to be documented.

Surveys shall be documented at least on the frequency given in Table 1 of this procedure.

Surveys shall also be documented every time contamination or radiation action levels are found, either by routine survey or as the result of a spill; refer to Table 2 and Table 3 for survey levels and required accompanying actions.

HOW TO DOCUMENT A SURVEY

Documented surveys shall reference a map of the area surveyed, or clearly describe the locations monitored. The generic survey form may be used. Records of the survey shall include

- Locations where swipe samples were taken;
- Printout results from swipes counting (Instrument printout shall be attached in its entirety, including counting date and instrument-specific information.);
- Removable contamination reported in disintegrations per minute (dpm) (If counts per minute (cpm) are recorded, then the record shall also include a documented conversion to dpm.);
- Locations where swipes indicated levels are above 200 dpm per 100 cm2, instrument contamination readings greater than 0.3 mR/hr, and area radiation levels are greater than or equal to 0.2 mR/hr;
- Instrument used;
- Date of survey;
- Name or initials of person performing the survey.

When contamination or radiation levels are found above Table 2 or Table 3 action levels, then records shall also indicate the corrective action(s) taken to eliminate or minimize the excessive levels found, including the print out results of the re-surveyed areas.

Inspection Survey Records shall be kept readily available for review by RW's, AU's, RSS, and NRC. A sample format for recording survey data is shown in a Documented Radiation Survey. AU's are free to design a format more specific to their laboratory needs.

Table 1
WHEN DO I NEED TO DOCUMENT A SURVEY?
(Use or Storage of Potentially Uncontained Materials)

Action Required	Daily	Weekly	Monthly
Instrument survey and Removable Contamination survey	Greater than 5 mCi of activity handled or in use at any one time	Greater than 1 mCi of activity handled or in use at any one time	Active Authorization

(1) Monitoring shall be performed after **each** use of uncontained radioactive materials and in the case of spills. Such surveys document the event and the effectiveness of corrective action or cleanup. **(2)** Surveys **shall** be documented on at least the frequency indicated above. **(3)** Surveys **shall** also be documented in the case of contamination or radiation levels in excess of action levels listed in Tables 2 and 3 (including documentation of corrective actions and results). **(4)** Instrument surveys are not required for tritium (H-3) or as stated in Special Conditions specifically approved for the authorization. **(5)** If active Authorization does not possess radioactive material, then monthly documented survey **shall** document that the survey meter(s) and LSC (or other swipe counters) are calibrated and functioning properly.

Table 2
REMOVABLE CONTAMINATION SURVEY LEVELS AND ACTIONS
(Swipes in dpm/100 cm2)

Contamination of	Less Than **200**	Greater Than **200 &** Less Than **2000**	Greater Than **2000 &** Less Than **20,000**	Greater Than or Equal to **20,000**
Personnel and/or clothing; areas outside restricted areas	ALARA	Control & Report immediately	Control & Report immediately	Control & Report immediately
Floor in restricted area; areas outside of Radioisotope Work Area	ALARA	Decontaminate, document & report by next work day	Control & Report immediately	Control & Report immediately
Designated Radioisotope Work Area	ALARA	ALARA	Decontaminate & document	Decontaminate, document & report by next work day
Labeled Equipment, Apparatus or Appliances	ALARA	ALARA	ALARA	Decontaminate, document, & if greater than 200,000 report by next day

Note: Report any spill involving greater than 1 microcurie (2,200,000 dpm) immediately!

Table 3
INSTRUMENT SURVEY LEVELS AND ACTIONS

ACTION	Instrument Surface Contamination Survey	Instrument - Area Radiation Level Survey
Decontaminate or shield, and document	Greater than or equal to 0.3 mR/hr @ 1 cm from surface	Greater than or equal to 0.2 mR/hr @ 30 cm
Control & Report immediately	Greater than or equal to 3.0 mR/hr @ 1 cm from surface	Greater than or equal to 2.0 mR/hr @ 30 cm

DOCUMENTED RADIATION SURVEY
UNIVERSITY OF MISSOURI-COLUMBIA

List all locations where the survey data exceed the levels listed below, if none indicate "none".
When laboratory ALARA or Survey Procedure action levels are exceeded, the actions taken must be documented in the comment section below

Instrument: Efficiency: (DPM= CPM/Eff) Calibration date:	Survey Meter Model No.:_____ Serial No.:_____ Calibration date:
Removable Contamination locations; Swipe(s) measurements greater than 200 dpm/100 cm^2:	Surface Contamination, locations with readings greater than 0.3 mR/hr @ 1 cm:
Comments:	Comments:

AUTHORIZED USER: _____ ROOM(S) & BLDG._____ Date: _____ Performed By:_____

HOW TO USE YOUR SURVEY METER

GENERAL

A survey meter is probably your most useful tool in assessing contamination in the laboratory when you are working with radioactive materials. It can be used to identify areas of contamination in the work area and to survey areas where you don't suspect contamination. It should also be used to check yourself to ensure that you have not contaminated your lab clothing, personal clothing and, most importantly, your skin.

Remember that when working with tritium (H-3) a standard G-M meter will not detect this isotope. You must rely on swipe data for meaningful information. Listed below are some helpful reminders on how to check your meter prior to surveys and how you should use them operationally.

PRE-OPERATIONAL CHECKS

Use your battery check switch to ensure that there is enough battery power to operate your meter.

If a check source is attached to the meter, use it and compare the results to those indicated on the calibration sticker. These numbers should agree within about 20%. If no check source is available, check the meter against a known radiation source to ensure that it responds to a radiation field.

OPERATION

When surveying for contamination using a pancake or thin-end G-M probe, use a slow sweeping (5-8 cm per second) motion about 1 cm away from the surface being tested. Be careful not to touch the face of the probe with a sharp object or the tube will puncture (about $100 to replace).

Remember to use the survey meter to check for areas where you also may want to swipe. Just because you can't see contamination on the meter does not mean that it is not there. Conversely, you may find contamination with the meter, but it may be "fixed" and not readily removable.

HOW TO USE YOUR LIQUID SCINTILLATION COUNTER

GENERAL

Before beginning actual system operation, the user should become familiar with the identification of all system controls and indicators and their functions as related to use during system operation by referring to the manufacturer's operation manual.

SAMPLE MEASUREMENT OPERATIONS

Ensure the power is applied to the system.

Ensure the printer has an adequate supply of paper for the operation to be performed, and that the printer is in the ON-LINE mode.

Load all standards and samples into the cassette.

Select the appropriate protocol designator (usually a flag or id plate) for either general surveys with the typical 3 window set up or full open window for labs that only use a particular low energy isotope, i.e. Tritium. If using a Packard, place the protocol designator on the first cassette of the batch. Reset the cycle flag by pushing the slide toward the front end of the cassette.

Load the cassette into the sample changer.

Close the cover on the sample changer.

Initiate counting by pressing the *Count Start/Stop* key, or *Auto Start* key.

Get print-out results from the counting of your samples and attach to survey maps. If counts per minute (cpm) are recorded, then the record shall also include a documented conversion to dpm. In addition the LSC print should also have the date, protocols, background, and efficiency listed.

If swipes' results are greater than 200 dpm, rerun those vials. The vial(s) may have to be placed in a cold area prior to the rerun.. This cooling down should eliminate any chemical luminescence. If sample's result is still higher than 200 dpm, initiate decontamination procedures.

CAUTION

The swipe protocols are defined to meet your day-to-day use of the system. They contain information like counting window settings of radionuclide's you might select. If you want to modify your swipe protocol contact your Assigned HP. All the efficiency information is posted on your counter on the calibration sticker. For those of you without automatic DPM, you need to use the posted efficiencies to convert counts per minute (CPM) to disintegrations per minute (DPM) by the formula of DPM = CPM/efficiency.

HOW TO PERFORM A SWIPE SURVEY

PREPARATION

Materials

- Drawing of the area to be surveyed,
- Swipes,
- Pen to mark the drawing and the swipes. Swipes need to be marked or pre-numbered by manufacturer to match the swipe location on the drawings,
- Scintillation vials and media,
- Liquid Scintillation Counter (LSC) and/or Gamma Counter, with a pre-programmed protocol or setting corresponding to the energy of the suspected contaminant (radioisotope),
- Survey meter to check contaminated swipes throughout survey for gross indication of contamination,
- Pad or envelope to secure or hold the swipes as they accumulate, such that they do not "cross- contaminate" other swipes, and
- Gloves, safety glasses, and lab coat.

Meter Contamination Survey

Should be performed first to identify “hot” spots to be swiped.

Identify swipe locations on drawing of lab

Number locations sequentially on drawing and on the corresponding swipe for that location. Start in areas with the least potential for contamination and proceed to the areas with the greatest potential for contamination. Identify the following:

- "Hot" spot locations identified with survey meter, i.e., > 0.3 mR/hr;
- "Use" areas, in addition to "hot" spots (floors, benches, equipment);
- Storage areas, where material is used,
- Waste,
- Material transport areas (to and from storage/use/waste areas),
- Areas you may have gone before surveying yourself (phone, desk, office, etc.),
- Entrance to lab (floor), "no-use" areas,
- Floor, desks, offices within lab, hallways, etc,
- Telephone, handles (drawers, equipment, faucets, meter knobs, etc.), door knobs.

REMOVABLE CONTAMINATION (SWIPE) SURVEY

Perform survey

"Swipe" areas with filter paper, making sure that the number on the swipe corresponds to the numbered location on the drawing, and that the area covered by the swipe is 100 cm^2.

Check suspected "hot" swipes with the survey meter so you can separate them from the rest of the swipes; a periodic check should be conducted of other swipes as well.

Swipes are now ready for sequential placement in scintillation vials and counting in the LSC or Gamma Counter.

The results should be analyzed and compared to the Removable Contamination Survey action limits of Table 2.

HOW TO RECEIVE AND OPEN PACKAGES CONTAINING RADIOACTIVE MATERIAL

DELIVERY OF THE PACKAGE

All packages containing radioactive materials are to be received at EHS for processing. The package will then be delivered directly to the authorized lab for which it was ordered. The outer package is surveyed during processing at EHS. The following procedure provides a final check of the radioactive material into the designated lab and helps prevent the inadvertent spread of contamination.

RECEIVING THE PACKAGE

The final step in receiving the package is signing the "Received by:" section on the receipt form. Signing the form transfers possession of the package from EHS to the lab. Do not sign the form unless you have been trained to properly handle the material.

Monitor the external surface for removable contamination and exposure rates, or check that the RS Office has performed these surveys and documented them on the receipt form. If a package is found to have greater than 2200 dpm/100 cm^2 (removable contamination), contact the RS Office immediately.

*If you receive a package containing radioactive material directly to your lab from the vendor, notify the RS Office **IMMEDIATELY***

OPENING THE PACKAGE

When opening packages containing radioactive material ALWAYS assume they are internally contaminated and wear gloves. Be extremely cautious with broken or crushed packages and those showing evidence of being wet.

Packages containing volatile compounds or packages containing more than 10 milliCuries should be opened in a properly operating fume hood or in a confinement box.

To open the package, you must be a RW and be trained to properly handle the material. Sign the "Package opened by" section on the receipt form, indicating who opened and surveyed the package.

Always inspect the package for integrity and evidence of leakage. Remove the radioactive materials and compare the vial labels and shipping papers. Verify that the radionuclide, chemical form, volume, activity and specific activity agree and are correct. Secure material from unauthorized access.

Monitor the empty packaging for removable contamination by swipe test and for fixed contamination by meter survey. If a package is found to have greater than 200 dpm/100cm2 of removable contamination, or meter survey results are above background, contact the Radiation Safety office immediately, otherwise remove or destroy all radiation signs or labels. Document the successful survey and label removal was performed by initialing in the "Verified by:" section on the receipt form, under "Disposal of Packaging".

Open the inner container in accordance with the manufacturer's instructions. Always check the labels on the inner container and vial to be sure the isotope and activity are correct. If the contents differ from your order or the outer paperwork, contact RS Office and the vendor.

Label all radioactive material containers with appropriate labels.

DISPOSAL OF PACKAGING MATERIAL, INNER CONTAINER, AND BOXES

After ensuring that no contamination exists, dispose of the defaced outer boxes and packing materials as ordinary waste.

If the packing material or inner container is recyclable and you wish to recycle the container, follow the manufacturer's instructions after insuring that no contamination exists as described above.

If the material was shipped in a plastic screw-top inner container, it may be disposed of or recycled as described in the Collection of Radwaste in Your Laboratory procedure.

***IMMEDIATELY** notify the RS Office of any problems with the delivery, receipt, opening, or if there is contamination of packages containing radioactive materials.*

HOW TO INVENTORY YOUR RADIOACTIVE MATERIAL

INVENTORY

The activity received should be logged; including the isotope, the current activity and the date whether or not you use RS Inventory Form, or use your own form for record keeping. Be sure to use the activity delivered to you not the activity that you requested from the vendor. These activities may differ by more than 50% for short half life materials.

As you remove activity from the stock material, note the date, the activity and the balance remaining in the stock.

Short half life materials, such as P-32, S-35, I-125, Rb-86, P-33 and Ca-45, should be periodically decayed to indicate what activities are present. Ideal dates for this decay period could be every two or four weeks for P-32 or the last day of each calendar quarter which will correspond with the RS Office quarterly inventory reports.

RADWASTE INVENTORY

Whether you use the Waste Record which is a part of the Radioisotope Receipt, Transfer, and Inventory Form, or use your own waste inventory log, the isotope, activity and date need to be kept for any material placed in a waste container. For short half life materials, be sure that the material placed in the container has been decayed to the date of disposal. Remember waste is included as part of your inventory until it is removed from your premises by EHS.

DISPOSAL RECORDS

When you request a waste pickup, all of these individual disposals must be decayed (if short half life material) to the date of the pickup request.

Keep your disposal records so that you can compare these with the Authorized User Quarterly Report records.

COLLECTION OF RADWASTE IN YOUR LABORATORY

GENERAL

Label all containers holding radwaste with a "Radioactive Hazardous Materials" label. Do not use a regular “Hazardous Material” label for radioactive waste. This label must be filled out in accordance with Hazardous Materials Management Manual.

Consider all activity in your radwaste as at part of your radioactive material inventory until it is physically removed by EHS personnel.

Secure and control your radwaste in accordance with the Control and Security of Radioactive Materials.

Segregate your radwaste by isotope. Do not mix isotopes in your radwaste unless required by your authorization.

Our disposal options are best managed for radwaste containing single isotopes.

Segregate your radwaste according to physical form. Do not put liquids, animal carcasses or animal tissues into solid radwaste; solids into liquid radwaste; or stock containers in with scintillation vials. Again, our disposal options are best managed for radwaste in one physical form.

Do not include hazardous materials with your radwaste unless it is absolutely required by your use. Disposal options for mixed waste (i.e., waste containing hazardous and radioactive materials) are greatly restricted, and disposal costs are extremely high. If you must include hazardous materials with your radwaste, contact EHS to review minimizing the volume of mixed waste.

Arrange for pickup of your radwaste within 6 months of the accumulation start date for each container.

Clean contaminated containers, plates or other materials by first rinsing them at least two times and collecting the rinsate as liquid radwaste. Contact your assigned HP to review any specific cleaning questions.

Dispose of any materials used with and around radioactive materials as normal trash only after surveying to show that it is not contaminated with radioactive material and after removing or obliterating any radioactive material labeling.

Do not add additional radwaste to any container after a pickup request form has been completed for that container.

Dispose of all radwaste only through EHS waste pickup. Some specific short-lived isotopes may be handled by specific procedures established as a special condition for an authorization. Contact your assigned HP to review any disposal questions.

SOLID RADWASTE (Dry)

Collect dry solid radwaste in fiber drums or other sturdy container lined with a poly bag.

Do not place free liquids or containers with greater than microliter quantities of liquid in your dry solid radwaste containers.

Puncture hazards must be collected separately either in appropriate sharps containers or in puncture resistant containers such as a cardboard box or plastic jug (glass, glass pipettes, etc.) to protect EHS staff. These containers shall be securely closed and then may be placed in your dry solid radwaste containers.

Keep separate from other solid radwaste all lead containers or lead items, and other dry solid hazardous materials contaminated with radioactive materials.

LIQUID RADWASTE

Store liquid radioactive waste containers in secondary containment.

The RS Office supplies gallon plastic bottles for collection of liquid radwaste.

Secondary containment shall be supplied by the AU and be of sufficient size to contain the volume of the primary container should it fail and therefore prevent a spill.

Keep liquid radwaste containers closed when not in use.

Keep the pH greater than 5.5 and less than 9.5.

Do not dispose of any liquid radwaste down your sinks.

SCINTILLATION VIALS

Collect scintillation vials as radioactive waste in the flats the vial came in. You may collect your scintillation vials in fiber drums lined with a poly bag if you ensure that the vial caps are tightly secured on each vial.

Use biodegradable or environmentally friendly liquid scintillation cocktails.

Dispose as radwaste all scintillation vials used with radioactive materials or used to do contamination surveys.

"Radioactive Hazardous Materials" labels for scintillation vials with **NO** activity should indicate "**SWIPES**", do not indicate any isotope.

ANIMAL CARCASSES

Collect small animal carcasses or animal tissues containing radioactive materials in poly bags and keep frozen.

If you will be disposing of larger animal carcasses, contact your assigned HP prior to any use to evaluate and schedule a timely pickup, storage and disposal.

ANIMAL WASTES

Contact your assigned HP to establish your specific procedures for handling animal wastes as radioactive waste.

ORIGINAL STOCK ITEMS AND CONTAINERS

If the stock vial is **NOT EMPTY**, place it in a "pig" for shielding and keep it separately for pickup.

If the stock vial is empty, it can be placed in solid radwaste.

Empty plastic screw-top containers can be placed in the solid radioactive waste as long as the top is unscrewed from the bottom.

Plastic covered lead "pigs" or lead shielding can **NEVER** be placed in solid radioactive waste. These items will be picked up separately for recycling and/or disposal.

PERSONNEL DOSIMETRY

REQUIREMENTS

Personnel radiation dosimetry is required for all persons that are likely to receive doses above 10 percent of the radiation protection limits or those who may enter a high radiation area.

Whole body badges should be worn as close to the midline of the body as possible between the waist and neck.

X-ray users may be assigned one or two whole body badges.

- If assigned one whole body badge, it shall be worn outside the protective lead apron.
- If assigned two whole body badges, one shall be worn under the lead apron and the second one shall be work outside the apron at the collar. These dosimeters are marked as to the correct location and it is important to be sure they are used correctly.

Finger dosimetry should be used by personnel routinely handling greater than one milliCurie of gamma emitters or beta emitters with beta energies above 0.2 MeV.

Finger or wrist dosimetry should be worn with the detector medium facing towards the radiation source.

Workers assigned personnel radiation badges shall wear them when working with radiation sources.

Personnel radiation dosimetry is to be worn only by the worker assigned the dosimetry.

If you are assigned dosimtery from the university which is used to monitor your work related occupational exposure to ionizing radiation, and plan to receive a diagnostic or therapeutic treatment with RAM (radiopharmaceuticals) then you MUST inform the RS Office PRIOR to the treatment so we can advise you on the particulars associated with how we are going to continue to monitor your occupational exposure without it being affected by the radiation from your treatment or scan.

It is not the intent of RS Office to interfere with any medical treatments or scans that might be medically necessary, but we do need to know if you are to receive a treatment that might impact the accuracy of your dosimeter

Dosimetry issued by the RS office is also not to be exposed to other sources of radiation at other facilities without consulting with the RS Office. This is also true for X-rays i.e. don't wear your work related dosimeter to a personal radiology scan e.g. doctor's visit.

Do not store your personal dosimeter close to sources of radiation. If you leave them on your lab coat or desk drawer as an example make for sure they are reasonably away from sources of ionizing radiation. In other words don't store you dosimeter near Radioactive Waste storage containers.

Ensure that you are wearing YOUR assigned dosimeter, wearing it correctly as identified on the dosimeter itself, "Chest", "Collar", and wearing the correct color and date on dosimeter associated with wear period. If you questions concerning your dosimetry contact your assigned HP at 882-7018.

EXPOSURE HISTORY

A permanent exposure history of all monitored personnel is maintained by the RS Office.

Annual dosimetry reports are provided for those individuals assigned personnel dosimetry that have been exposed to occupation radiation greater than 100 mrem/yr. However anyone who is monitored by dosimetry can ask to see a copy of their record.

SPILLS, CONTAMINATION, RADIATION EMERGENCY PROCEDURES

MINOR SPILLS

- Notify person(s) in the area that a spill has occurred.
- Prevent the spread of contamination by covering the spill with absorbent paper.
- Survey the area with a survey meter and then determine removable contamination levels by performing the swipe survey. Check the area around the spill for contamination. Also check hands, clothing, and shoes for contamination.
- Consult Tables 2 and 3 on specific actions for given swipe and instrument surveys contamination levels.
- If required, report the incident to the RS Office.
- If decontamination is recommended, clean up the spill, using absorbent paper and wearing disposable gloves and protective clothing (lab coat).
- Carefully fold the absorbent paper with the clean side out and place in a radioactive waste container. Put contaminated gloves and any other contaminated disposable material in a radioactive waste container.
- Upon decontamination completion, check the area around the spill. Check hands, clothing, and shoes for contamination before exiting the area.
- As necessary decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water, then washing with mild soap.

MAJOR SPILLS AND INCIDENTS INVOLVING RADIOACTIVE DUSTS, MISTS, FUMES, ORGANIC VAPORS AND GASES.

For major spills or incidents involving radioactive dusts, mists, fumes, organic vapors, and gases use the "Radiation Emergency Procedures."

RADIATION EMERGENCY PROCEDURES

EMERGENCY NUMBERS

FIRE DEPT	**911**	**RADIATION SAFETY OFFICE (DAYS)**	**882-7221**
AMBULANCE	**911**	**RADIATION SAFETY OFFICE (NIGHTS)**	**882-7201**
MU POLICE	**882-7201**	**HOSPITAL AND CLINICS (NIGHTS)**	**882-7979**
HOSPITAL	**882-7079**	**ELLIS FISCHEL**	**911**
		COLUMBIA REGIONAL HOSPITAL	**9333**

(FOR INFORMATION ONLY DO NOT USE)

A. FIRE EMERGENCIES INVOLVING RADIATION

1. Call Fire Department **(911)** and give nature and location.
2. Set off fire alarm.
3. Assist in evacuation of area if necessary.
4. Inform emergency personnel that radiation hazard may exist.
5. Notify the Radiation Safety Office **(882-7221).** At night, on weekends, or holidays call MU Police **(882-7201)**.

(FOR INFORMATION ONLY DO NOT USE)

B. MEDICAL EMERGENCIES INVOLVING RADIATION

1. Call ambulance **(911)** if necessary.
2. Assist in contacting individual's personal physician and, if a student, contact Student Health Center **(882-7481)**.
3. Inform medical personnel that a radiation hazard may exist.
4. Notify the Radiation Safety Office **(882-7221).** At night, on weekends, or holidays call MU Police **(882-7201)**.

(FOR INFORMATION ONLY DO NOT USE)

C. RADIATION SAFETY PROCEDURES

1. Evacuate personnel from the radiation area.
2. Assemble all personnel in nearby safe area until radiation surveys and personnel decontamination are performed by the Radiation Safety Office.
3. Prevent spread of contamination from accident site. Use nearest telephone for communications and avoid walking throughout the building.
4. Close doors and windows and, if possible, turn off air equipment that might transfer radiation contamination throughout the building.
5. Control access to the radiation area and place warning signs indicating any radiation and contamination hazards.
6. Notify the Radiation Safety Office of incident **(882-7221)**. The Radiation Safety Office may be contacted during off-duty hours through the University Police **(882-7201)** or the University Hospitals Emergency Response **(882-7979)** or Ellis Fischel Emergency Response **(911)** or Columbia Regional Hospital Emergency Response **(9333)**.
7. Decontamination of rooms and building shall only be done under the supervision of the Radiation Safety Office.

LABORATORY PERSONNEL

Name	Day Phone Number	Night Phone Number
(FOR INFORMATION ONLY DO NOT USE)		

QUANTITIES OF RADIOACTIVE MATERIALS REQUIRING FUME HOOD USE

FUME HOOD OR GLOVE BOX

Fume hoods or other forms of secondary containment must be used when working with greater than one milliCurie quantities of a radioactive material bound or incorporated into a chemical or physical form, which may easily become airborne or volatile.
For example:

- dusts
- iodine's
- compounds which have a high vapor
- pressure
- compounds which sublime
- any actions which may cause atomization, etc.

Experiments with commonly authorized radionuclide's (I-125 or I-131 sodium iodide, S-35 methionine, H-3 as tritiated water and less frequently C-14 labeled organic solvents) may produce volatile materials. Any chemical or physical form that readily volatilizes or evaporates or any experimental procedure that may liberate airborne materials must be considered an airborne risk and should be handled in a properly operating fume hood

BIOASSAY REQUIREMENTS

Specific bioassay requirements exist when working with certain quantities of isotopes; I-125, I-131, and Tritium are the most common.

INFORMATION ON VOLATILITY

The Material Safety Data Sheets (MSDS) should be consulted to determine airborne hazard for the specific chemical compounds in question involved in the use of the radioactive material reactions in question. The MSDS may provide some guidance as to the volatility of the compounds and/or solutions but will not specifically address the radioactive properties.

HOW TO SURVIVE INSPECTIONS FROM THE RADIATION SAFETY OFFICE

WHEN TO EXPECT AN INSPECTION

Monthly Schedule: Those in this category should expect an inspection almost any time during the month. The inspections are usually unannounced.

Quarterly Schedule: Before RSS visits your lab, you will generally receive a call to schedule a convenient time. Unannounced lab inspections, though, are not uncommon.

Semi-annual Schedule: Those in this category can expect a call from RSS before an inspection most of the time. Unannounced lab inspections, though, are not uncommon.

HOW TO PREPARE FOR AN INSPECTION

The best way to "survive" an inspection is to make sure that everyone working with radioactive material is well trained and is always concerned about radiation safety in your lab. You also need to make sure the following items are checked on a routine basis.

Inventory

Are the receipts logged in as received and the use of material logged as the use occurs?

Did I log in transfer activities and notify the RS Office about the transfer?

Is material logged into waste? Note activity in waste is still on inventory until EHS removes it from lab.

Did I double contain the liquid waste and label the containers properly?

Do I need to request a waste pickup?

Does the "balance on hand" in the quarterly report reflect the actual activities I possess?

Did I use the proper dates for the decayed values?

Contamination

Have any spills occurred, and if action levels were exceeded, was this reported to the RS Office?

Was the spill recognized at the time of the event or discovered by lab survey?

Did the contamination exceed the action levels in the Procedures for Surveys and was the action taken, proper and complete?

Documented Surveys

Did I use an area survey map, do the survey maps have all the pertinent information filled out, i.e. swipe locations, meter s/n, instruments calibration dates, etc.?

Are removable contamination survey results recorded in DPM, and the meter survey results in mR/hr?

Are the meter and removable contamination surveys being performed on a frequency according to Procedures for Surveys?

Are documented survey results readily available?

Instrumentation

Are survey meters operational and calibrated within the acceptable calibration period?

Is every RW able to demonstrate proper operation check for your survey meter(s)?

Is every RW able to perform a meter and swipe survey?

Safety Precautions

Is the protocol of no eating, drinking, and smoking being followed in your laboratories?

Is protective attire being worn when you handle radioactive materials?

Are work areas, and personnel monitored for contamination during use of radioactive material and then surveyed after completion of each work period. Do survey records support this?

Posting

Is the lab posted with adequate radiation warning labels?

Are potentially contaminated labware and equipment labeled appropriately?

Are the updated versions of NRC Form 3 and the Radiation Emergency Procedures posted?

Performance-Based Evaluations

Be prepared to answer Performance-Based-Evaluation questions.

Do you know your authorization's radiation program well?

These questions are always related to your authorization's day-to-day radioactive material handling, record keeping, survey performance, etc.

ADMINISTRATOR RESPONSIBLE FOR AUTHORIZED USER

RESPONSIBILITIES

TRAINING AND PERFORMANCE BASED EVALUATIONS

Communicate to employees, students, visitors and guests that the health, safety, and concern for the environment are top priorities on the MU campus, and that everyone shares the obligation to perform work in a safe, healthful, environmentally protective manner.

Ensure radiation safety obligations are met in the departments or units under your control.

MATERIAL CONTROL

Ensure that AU's and RW's utilize the "As Low As Reasonably Achievable" (ALARA) principles with respect to radioactive materials and radiation.

Set expectations for, and support the AU's efforts in establishing authorization-specific procedures.

ASSESSMENT AND CORRECTION

Set expectations and support the AU's efforts in performing self-assessment activities, and implementing corrective actions.

WHAT MUST BE DONE

TRAINING AND PERFORMANCE-BASED EVALUATIONS

Review authorization applications for use of radioactive material and demonstrate support of AU's training and experience, and the proposed use and facilities by signing the application.

MATERIAL CONTROL

Review authorization applications and demonstrate support of AU's facilities, authorization-specific procedures, and permission to do the work by providing a signature endorsement of the application.

ASSESSMENT AND CORRECTION

Review the AU's inspection records to evaluate performance and identify any improvement opportunities if necessary. For any inspection that resulted in a deficiency level of "A" or "B" the administrator should assist in establishing corrective actions as necessary.

ADMINISTRATOR PROCEDURES IN SUPPORT OF THE AUTHORIZED USERS

SUPPORT OF AUTHORIZED USER

The types of support provided by an Administrator to an AU includes the use of facilities (rooms, labs, equipment, etc.) and the use of the departmental resources such as clerical, purchasing, maintenance, security, etc.

The Administrator who directly supervises the AU is actively involved in the authorization process by signing the Authority Page for each application made by the AU.

There are situations when an Administrator provides support to an AU who is not supervised by that Administrator, but is allowed use of facilities that the Administrator supervises. In this case, the Administrator shows his support by signing the Authority Page under the "Supervisor Support for Other Areas" (See Application for Authorization).

INSPECTION FOLLOW UP

AU's are periodically inspected. If an inspection identifies a high deficiency score, like a level A or B deficiency, the Administrator will receive a copy of the Inspection Report. The Administrator should follow up with the AU to ensure that actions are being taken to identify the root cause(s) and that corrective actions are initiated to prevent reoccurrence.

REMOVAL OF APPROVAL

The Administrator may remove partial or total support from the AU. That removal of support should be made in writing to the RSC with copies to the AU and the RSO.

PERIODIC REVIEW

The Administrator will receive periodic reviews of the AU's that they directly supervise or are allowed to use their facilities. These reviews may consist of lists of the AU's, approved use areas, isotopes, RW's or inspection results. The Administrator may request this information for any of their AU's at any time by contacting the RSO.

SECURITY

The Administrator is involved in security of radioactive materials by controlling the issuance of keys for restricted areas and by keeping the AU appraised of who has keys issued for their restricted areas.

The AU can then implement additional controls if needed and ensure that ancillary training is given to individuals with access to the restricted areas.

All individuals with key access to the restricted area are responsible for security of radioactive material within the area or lab.

ANCILLARY WORKER

(All Students, Faculty, and Staff having access to MU Facilities with Radioactive Material)

RESPONSIBILITIES

TRAINING AND PERFORMANCE-BASED EVALUATIONS

Seek instruction from the authorized personnel in understanding your responsibilities for access to restricted areas.

Be acquainted with and understand your responsibilities toward providing colleagues, staff, students, and visitors with a safe work environment.

MATERIAL CONTROL

Observe related signs, posters, warning signals and directions. Assist in maintaining security and control of radioactive materials when you have access to restricted areas that contain them.

ASSESSMENT AND CORRECTION

Notify authorized personnel of any unusual circumstances observed regarding work place safety.

PROCEDURES

ACCESS AND SECURITY

As an Ancillary Worker, you have access to radioactive materials or radioactive work areas. You are not allowed to handle radioactive materials except under the direct supervision of an AU or RW.

You are responsible for ensuring security of radioactive materials from unauthorized access or removal. This means

- If someone unfamiliar to you enters the restricted area containing radioactive materials, you should ask them to identify themselves and not let them have access to the material.
- If a workman comes in to do work in a restricted area, you should direct them to the AU or RW responsible for the area, or be completely briefed by the AU or RW as to what the workman is allowed to do and not to do.
- If someone is delivering radioactive materials, you are not allowed to accept the material. You must find the AU or a RW to accept the delivered radioactive material.
- If you are the last person to leave the restricted area, then you are responsible for locking the area.
- You are responsible for reporting any unusual circumstance with regard to work place safety to the AU or RW responsible for the restricted area.

TRAINING

You must receive training to understand the specific requirements for the particular restricted areas to which you have access. You may receive training from the AU or RW.

MU's Campus Facilities (custodians, maintenance, construction, energy management, etc.) receive ancillary training from the RS Office or from the University of Missouri-Columbia Research Reactor (MURR). Hospital Support Staff (housekeeping, plant engineering, etc.) receive ancillary training from the RS Office. All these individuals are encouraged to discuss specific requirements with the people responsible for any restricted areas that they must enter.

RADIATION SAFETY COMMITTEE

MANAGEMENT AND RADIATION SAFETY

RESPONSIBILITY

The responsibility for the governance of the University (MU) is vested in the Board of Curators.

Executive responsibility and authority for administrating the University is assigned to the President. The President delegates responsibilities and authority to conduct operations on and by the University Campuses to the Chancellors.

The Chancellor is responsible for negotiating the Nuclear Regulatory Commission Licenses for the University of Missouri – Columbia.

The Chancellor has delegated this responsibility to the Vice Chancellor for Administrative Services.

Licenses of all types needed by the University are issued in the corporate name of the University: The Curators of the University of Missouri.

DELEGATION OF RESPONSIBILITY

Policies related to the management of programs utilizing radiation except those at MURR are established by MU's RSC.

Implementation of MU's RSC policies is the responsibility of the RSO.

The RSO is appointed by the Chancellor upon recommendation of the Vice Chancellor for Administrative Services and the Vice Provost for Research.

GENERAL INFORMATION

GENERAL

The Radiation Safety Committee (RSC) advises the Chancellor through the Vice Provost for Research on all matters relating to the safe use of radiation. The Vice Provost for Research is responsible for appointing members and assigning the chairperson to the RSC. Membership is constituted to satisfy the requirements as outlined in 10 CFR 33.

A representative from campus management and persons knowledgeable in the application and uses of radioactive materials will be included in the RSC membership.

The RSO will be an ex-officio, non-voting member of the RSC. An Alternate Chair may be designated from within for special purposes upon a proper motion and vote by the RSC.

DUTIES OF THE RSC

- Review and approve or deny the uses of radioactive materials by MU personnel, except for medical uses.
- Advise the campus administrators on matters relating to radiation safety.
- Review the performance of the RSO, the RSP and the RSS to assure maintenance and adequate control of radiation risks.
- Oversee an annual program audit and make recommendations to management on continued maintenance of the operational radiation safety program. This annual program audit will be used to identify areas of noncompliance within the program. These areas of noncompliance will then be analyzed, corrected and then actions will be instituted to prevent recurrence.
- Develop and direct implementation by the RSO of the University policies for proper uses of radioactive materials and review all general guidelines and/or procedures issued by the RSO.
- Create special quorums within the Committee to approve user authorization and to generally oversee and review various disciplines. Such special quorums could include but are not limited to areas such as medicine and human use, biological and physical science, engineering and veterinary science.
- Develop safety manuals as necessary to ensure proper program implementation and good health physics practices.
- Establish methods for maintaining records of the RSC's proceedings.
- Review and approve all new requests for authorization and requests for significant changes in existing authorization.
- Empower the RSO to issue interim authorizations, including changes to existing authorizations, and amendments of a non-signification nature, e.g., minor increases in quantities, use of isotopes in the same or lower toxicity group as currently authorized, and movement to a laboratory of equal or improved design.
- All interim authorizations issued by the RSO must be reviewed and approved at the next RSC/Medical Use Quorum (MQ) meeting.

QUORUMS

GENERAL QUORUM

A simple majority of the RSC shall constitute a general quorum. This general quorum shall be the minimum number of members required to be present at a meeting in order to transact business on behalf of the RSC. A general quorum shall always include individuals representing the following positions: Chair of the RSC or the properly appointed alternate, RSO, member of management, at least one person knowledgeable in the area of the radiation currently being discussed, and any other individuals required by applicable state or federal regulations.

SPECIAL QUORUMS

Special quorums shall be those quorums created by the RSC for the purpose of overseeing and reviewing various disciplines within the radiation safety program. A special quorum shall always include individuals representing the following positions: Chair or Associate Chair (who shall be appointed and approved by a simple majority vote of the Committee), RSO, a representative from management, at least one person knowledgeable in the area of specialty of the quorum, and any other individuals required by federal or state regulations or deemed appropriate by the RSC.

When a Special Quorum reviews an application for use by an individual user, it shall do so by first informing the RSC. Such information would include the name of the applicant, a general summary of the applicant's experience and nature of the proposed use. Such information shall be distributed with adequate time for notice and comment by the RSC members prior to special quorum review of said application. If comments have been submitted, such comments shall be discussed at a special quorum meeting prior to approval/denial of said application.

The RSC shall have power to overrule any or all authority of a special quorum which reports to the RSC.

MEDICAL USE QUORUM

A special quorum of MU's RSC is responsible for the radiation safety review of all human use applications and for oversight of the University of Missouri Healthcare RSP. This special quorum functions as the hospital's RSC as required by NRC regulation 10 CFR 35. The special quorum membership, including the Associate Chair, shall be appointed by the Vice Provost for Research with recommendations from the Dean of the School of Medicine and the Director of the University of Missouri Healthcare. In order to conduct business, a simple majority of the quorum membership must be present and must include the Associate Chair (or properly appointed alternate), the RSO, a member of hospital management, a representative of nursing services and at least two persons with expertise in medical uses of radiation.

The duties of the MQ consist of three primary functions:

- Review all applications for radiation safety compliance when materials are used in humans before action is taken by the RSC.
- Serve as a Hospital RSC as defined by 10 CFR 35.
- Furnish consultation to the Institutional Review Board and the Vice Provost for Research.

PROCEDURE FOR CONDUCT OF BUSINESS

The MQ and the RSC shall meet as needed to conduct the business of the University.

A simple majority of those individuals present shall be used to approve motions for the Special Quorums and MQ's.

The MQ shall conduct business in the following order::

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

The RSC shall follow the above procedure; however, they shall also have the responsibility to review any quorum reports.

All items discussed by the RSC and the quorums shall be documented.

ADMINISTRATIVE SUPPORT

The Vice Chancellor for Administrative Services is responsible for providing adequate support for RS Office operations on the campus. The RSC shall curtail current and/or future campus radiation programs whenever it determines adequate RS Office support is not or cannot be provided. Any proposed curtailment of campus radiation programs because of inadequate RS Office support shall be reported by the committee chairperson to the Vice Provost for Research and to the Vice Chancellor for Administrative Services.

AUTHORIZATION APPLICATION REVIEW AND APPROVAL POLICIES

GENERAL

The following review and approval scheme has been adopted by the MU RSC to process changes in authorizations in a timely fashion while providing a level of review and approval commensurate with the requested change. The level of review and approval may be moved to a higher level of the review team feels circumstances warrant an increased level of review and approval.

ADMINISTRATIVE CHANGES

- **Request:** Request of change by AU, Administrator, or RSO
- **Review/Approval Chain:** HP (as needed), RSO
- **Change:** RSS records updated; updated authorization form may be issued at that time or at the next amendment; RSC updated on amendments issued.
- **Types:** Name; degree; job title; department (without change in authorized administrative reporting); office address; telephone numbers; e-mail address; type of instrument used; change in RW's approved to work under authorization; change in order amount limit up to possession limit; reduction or removal of isotope possession limit; use area inactivation or closeout; inactivation or reactivation of authorization; authorization termination; addition or removal of Secondary User; change in Primary User in existing co-authorization.

MINOR CHANGES

- **Request:** Authorization application submitted by AU.
- **Review/Approval Chain:** HP, RSO, RSCR.
- **Change:** Authorization amendment issued and RSC periodically updated.
- **Types:** Use area addition; minor change in plan for investigation and authorization-specific radiation safety procedures; minor change in radioactive material use rate and waste disposal; minor change of special conditions; renewal application without change, or with reduction or removal of isotope, or with change of use area; temporary transfer of authorization.

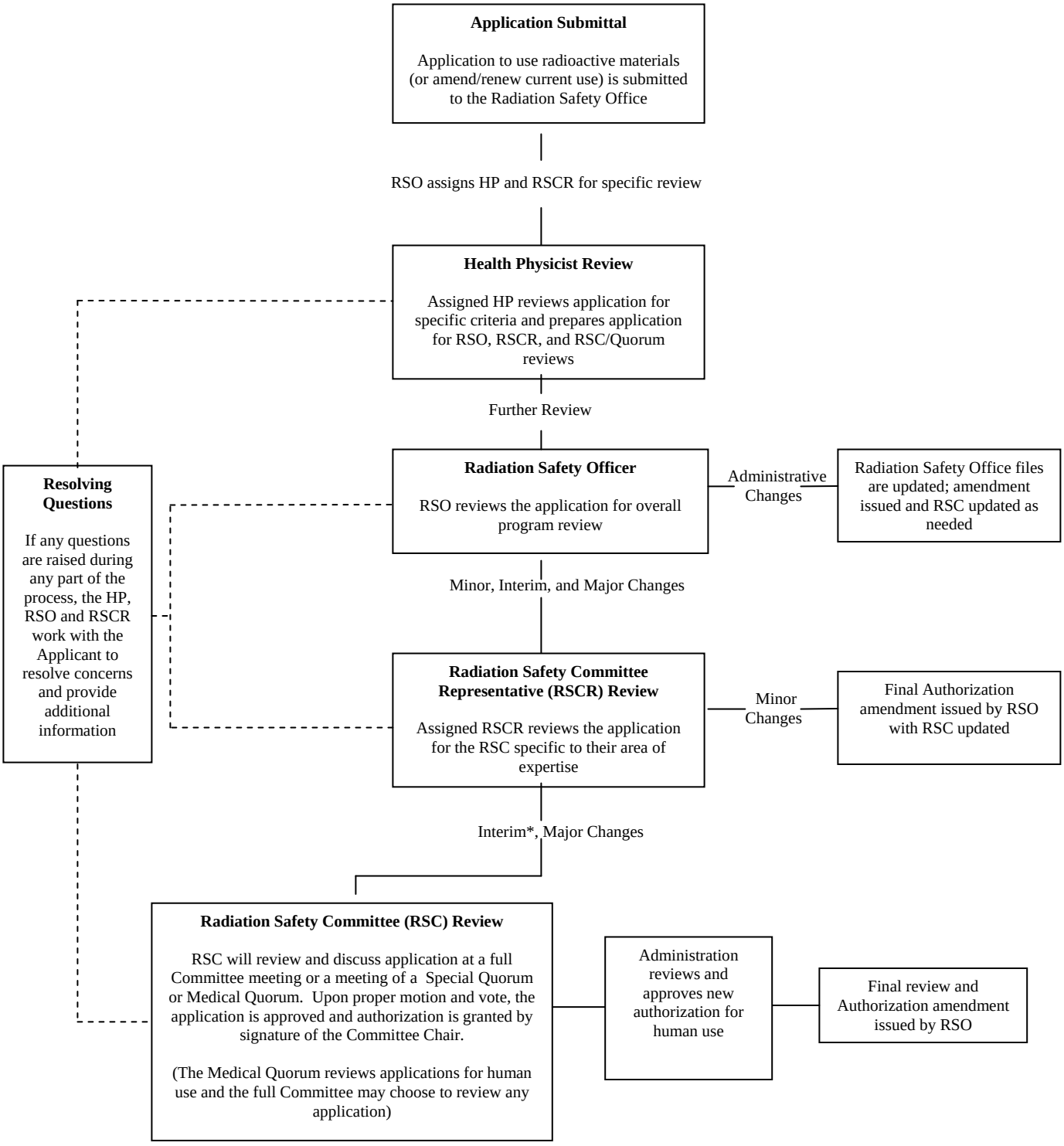
INTERIM CHANGES

- **Request:** Authorization application submitted by AU; interim approval may be requested.
- **Review/Approval Chain:** HP, RSO, RSCR, RSC.
- **Change:** Interim authorization amendment issued following approval by RSCR (if requested) and final authorization amendment issued following approval by RSC.
- **Types:** Increase in possession limit or type of isotope which is not a higher hazard class or inspection class; new AU (interim approval issued for less than or equal to 1 mCi per isotope); renewal with isotope increase or addition.

MAJOR CHANGES

- **Request:** Authorization application submitted by AU.
- **Review/Approval:** HP, RSO, RSCR, RSC.
- **Change:** Authorization amendment issued only following approval by RSC.
- **Types:** Increase in possession limit or type of isotope which is a higher hazard class or inspection class; major change in plan for investigation and authorization- specific radiation safety procedures; major change in radioactive material use rate and waste disposal; major change of special conditions (e.g., modification of restricted area); new AU; renewal with major changes.

Authorization Application Review Flow Chart



*Interim authorization may be issued by the RSO prior to final RSC approval

ENFORCEMENT PROCEDURES

GENERAL

The RSS will inspect facilities, perform surveys, and verify inventories, etc, for compliance. The inspection is essentially an ALARA audit of each AU's radiation safety program. These inspections of the authorization radiation safety program are crucial to maintaining radiation exposures ALARA.

The inspections also document that the individual radiation safety programs are being conducted in compliance with MU's License conditions and commitments granted by the NRC. An escalated enforcement format is based on the fact that there are items which are of more importance than others, based upon the repercussions which could result from noncompliance. A four tiered enforcement strategy is proposed.

While all deficiencies can lead to violations imposed by the NRC, the tiered enforcement reflects the level of hazard and the level of corrective action necessary.

DEFICIENCY LEVELS

"D" Level Deficiencies are those of an administrative, documentation or record keeping type.

"C" Level Deficiencies are associated with the AU's radiation safety program confirming the safe use of radioactive materials.

"B" Level Deficiencies are those which, if continued, could result in the NRC issuing a violation, and perhaps assessing the University and/or responsible individuals a monetary fine. This level of deficiency would require timely remediation of the situation by the AU and the RSS.

"A" Level Deficiencies are the most serious from the potential damage/injury to the environment, RW's, general public and may require immediate reporting to the NRC, which could result in issuance of violations and monetary fines. This level of deficiency would require immediate cessation of the project by the RSS in order to control the situation.

AU RESPONSE TO DEFICIENCIES

Response to the violations is based upon the type of deficiency and the progress that the AU has demonstrated in correcting previous problems. In all instances the AU will be informed of the deficiency. The AU will be held responsible for correcting deficiencies and ensuring compliance of his/her authorization. Consideration for immediate corrective action will be a factor in the prescribed response required:

- **"D" Level Deficiencies** - - The AU will be informed of the deficiency in the inspection report. As this level of deficiency is minor, they can usually be corrected immediately on the spot. The assigned HP may discuss corrective mechanisms with the AU and staff. The AU will insure that the deficiency has been corrected in a timely fashion and typically review of the correction will occur at the next inspection.

- **"C" Level Deficiencies** - - The AU will be informed of the deficiency in the inspection report. Typically, the deficiency will be discussed by the assigned HP with the AU. The AU will be required to take corrective action within a given time period to correct the deficiency. The RSS will follow up at the end of the time to assure the deficiency has been corrected.

- **"B" Level Deficiencies** - - The AU will be told of the deficiency immediately by the inspector or the assigned HP. The deficiency will be discussed by the assigned HP with the AU. The AU will be required to take corrective actions in a time period established to correct the deficiency. The corrective action will require a written response from the AU to the RSO as to what the deficiency was, why the deficiency occurred, and the remedial action that the AU has taken to assure that it will not recur in the future. The inspection report will be forwarded to the assigned RSCR for their consideration and discussion with the AU and the RSC. Informational copy will be provided to the AU's Administrator.

- **"A" Level Deficiencies** - - The AU will be told immediately of the deficiency by the Inspector. The operation will be immediately curtailed, the deficiency will then be discussed and the AU will be required to take corrective action within an immediate time period established to stabilize and control the operation. The incident will be immediately reported to the RSO and the assigned HP. The potential health and safety, and regulatory implications will govern the remedial actions required. Potentially the AU's authorization may be immediately suspended. Reactivation of the authorization will not occur until a RSC review has been conducted. The AU will be required at a minimum to report to the Committee what occurred, why it occurred and how the AU intends to prevent a recurrence and ensure safe continuation of the authorization. Any documentation developed by the AU and personnel involved, or by the RSS and RSO will be completed on a time frame compatible with NRC reporting requirements. Informational copies will be provided to the AU's Administrator.

NOTE: Deficiencies will be assigned at time of inspections. Notification of a problem to the RSS will not result in issuance of a deficiency. However, an inspection may be conducted at any time and deficiencies issued if corrective actions have not been implemented in a timely manner. Recurrent deficiencies may escalate the enforcement action to the next level.

At the time of inspection, the RSS may interact with a knowledgeable RW's whom the AU's have designated to act in their absence.

DEFICIENCY LEVELS
EXAMPLES OF AUTHORIZATION DEFICIENCIES

Class of Deficiency	Type/Examples	AU Corrective Action	RSS/RSO/RSC Follow-Up

D - Level	Administrative; e.g.,
	• Poor or incomplete record keeping such as;
	  o No meter or LSC listed on survey maps
	  o Initials missing on Package receipt
	  o No CPM to DPM conversion
	  o Calibration dates on survey maps out of date.
	• Minor deficiencies immediately corrected.
	• Out of date HML
	• Security violation but no significant exposure risk to public, e.g. ppg, or low activities of low energy isotopes.
		Complete or correct deficiency	RSS verifies corrective action and documents in AU file

C - Level	Minor program violations; e.g., • Improper waste storage, i.e. no secondary containment • Missed Radiation Survey for month • No HML on waste • Minor contamination found during inspection unidentified by AU's surveys • Improper ordering, • ALARA response deficiency, • RSS identified Corrective Actions to Prevent Re-Occurrence from previous inspection results not followed. • Evidence of Personal Safety violation- (broken glass in improper waste container) • Security violation where access to significant items presents exposure risk to public, e.g. Stock Vials but < 2mr/hr • **Escalation of D – Level**	Immediate response to correct if possible; or correct deficiency within specified time frame	• RSS verifies corrective action and documents, • Technical follow up and documentation of corrective action/notify HP, • HP may visit/call
B - Level	Major program violations: e.g., • Evidence of food and/or drink, • Major contamination, • Spread of contamination, • Program violation due to inadequate personnel training, • No Surveys performed for more than one month. • Security violation where access to radiological items or sources presents exposure risk to public > 2 mR/hr. • **Escalation of C – Level**	Respond to RSO with corrective actions in writing including: • Reasons for problem, • Immediate remediation of problem, • How it will be prevented in the future.	• RSCR notified/ may visit with HP, • RSO notified, • HP will visit and present summaries to RSCR and RSO, • May suspend authorization temporarily
A - Level	Major loss of program control; e.g., • Lack of control of material, • Spread of contamination to unrestricted areas, • Any NRC reportable event, • Personnel exposure in excess of limit, • **Escalation of B – Level**	Immediate cessation of operations • Immediate notification of RSO; • Suspend operations pending review; • Respond to RSO with corrective actions in writing including reasons for problem, immediate remediation of problem, and how it will be prevented in the future	• RSO verifies cession of operations; • Notify RSCR and RSC Chair; • Notify NRC if required; • May suspend authorization; • If authorization has been suspended, AU must report to RSC and describe corrective actions and formally request re-instatement of authorization

RADIATION SAFETY OFFICE

RADIATION SAFETY OFFICE

GENERAL

The RS Office operates out of the Department of EHS.

The primary objective of the RS Office is to administer and oversee the technical aspects of the Radiation Safety Program at MU.

At MU the RSS makes up the technical personnel for the RS Office. The RSS is typically comprised of but not limited to an RSO, Deputy RSO (DRSO), HP's, and Environmental Health Technicians (EHT's).

RADIATION SAFETY OFFICER RESPONSIBILITIES

GENERAL

The Vice Chancellor for Administrative Services is responsible for providing adequate radiation safety support and surveillance to the MU programs. The RSO directs the RS Office unit, which is part of the Environmental Health and Safety Department. The RSO reports through the Director of EHS to the Vice Chancellor for Administrative Services. The RSO qualifications shall meet the applicable NRC requirements.

RESPONSIBILITIES AND DUTIES

- Implement the policies of the RSC.
- Review all applications for uses of radiation to ensure compatibility with appropriate license conditions.
- Issue and authorize the use of radioactive materials.
- Approve and/or coordinate transfer of radioactive material.
- Restrict or suspend use and/or possession of radioactive materials whenever a significant deviation from established guidelines and procedures has occurred. Such deviation of use shall include any threat to health or property.
- Provide liaison to the NRC in negotiations for licenses through the Vice Chancellor of Administrative Services.
- Provide consultation on radiation safety problems to authorized users, to health physics staff members, and to others having a need for the information.
- Provide staff assistance to the RSC as required.
- Design, arrange for the printing, and maintain a supply for distribution of all required forms.
- Write and publish guidelines and/or procedures for radiation safety.
- Report incidents, as required to the applicable regulatory agency. Descriptions of these incidents shall be provided to the RSC and to Campus Administration.
- Regularly inspect laboratory facilities of each investigator authorized to use radiation sources by the methods and frequency developed in collaboration with the RSC.
- Define the procedures for response to emergency situations in order to provide prompt and positive corrective action. These procedures are to be reviewed annually.
- Supervise all ordering, receipt, survey, monitoring and delivery of all shipments of radioactive material arriving at MU.
- Conduct and coordinate all training programs of MU personnel in the proper procedures for the use of radioactive material.
- Supervise and coordinate the radioactive waste disposal program.
- Oversee the storage of radioactive material, including radioactive waste.
- Maintain inventory of all radioisotopes.
- Supervise decontamination and recovery operations.
- Perform or arrange for leak tests on all sealed sources and calibration of radiation survey instruments.
- Issue/Monitor dosimetry.
- Maintain all appropriate records including minutes of all RSC meetings.

MU RADIATION SAFETY TRAINING PROGRAM

GENERAL

Initial training requirements for AU's are given in the Authorization Application Training and Experience Page. Initial training requirements for RW's are given in How to Train RW's. MU's NRC License requires that AU's and RW's periodically have refresher training. The Radiation Safety Training Program conducted by the RS Office is designed to meet these training requirements.

DESCRIPTIONS OF RADIATION SAFETY COURSES AVAILABLE

Radiation Awareness Training for Ancillary Personnel: This course is designed to train ancillary personnel, who may work unescorted in radiation use areas, on radiation protocols, and security issues. This course is provided each year for custodians and housekeepers.

New Authorized User Review of the Radiation Safety Program: This course offers an introduction for new AU's to the MU RSP. It also gives the RSO a chance to become acquainted with new AU's. This training is required for every new AU.

Radiation Contamination Control: This course gives instruction on how to identify and control radioactive contamination within the laboratory.

Radiation Decontamination: This course gives instruction on how to clean up radioactive contamination in the laboratory.

Radiation Contamination Detection: This course is concerned with detecting radiation contamination in the laboratory.

Radiation External Training: This gives trainees credit for attending Radiation Safety courses outside the University of Missouri – Columbia. The RSO will evaluate all external training based on course outline and proof of attendance. Credit is given based on this evaluation.

Implant Therapy Personnel Training: This course advises nurses on regulation and procedures that need to be followed for radioactive implant therapy. Each time a patient undergoes a therapy the nurses assigned to the patient go through this training.

Operating Procedure for the GR-12 Irradiator: This course is designed to instruct the trainee on the operating procedure for the GR-12 Irradiator.

Nuclear Medicine In-Service: This course is designed to train Technologists and Doctors on regulations and procedures for using radioactive materials.

Veterinary Radiology In-Service: This course is designed to advise Technicians and Doctors on regulations and procedures that need to be followed for Veterinary Nuclear Medicine.

RAD – MURR Indoctrination Training: This training is held outside EHS. Training is directed at personnel from Campus Facilities, Energy Management, MU Police and RW's under the Health Physics Manager of MURR. It is designed to train such personnel in radiation safety and their responsibilities so they may work unescorted at MURR.

Introduction to Radiation Safety at MU – New Radiation Workers: This course is designed to give new RW an introduction to the Radiation Safety Program at the University of Missouri – Columbia.

Radiation Safety at MU – Update: This course is designed to give experienced RW's an update course on the Radiation Safety Program at the University of Missouri – Columbia.

Radiation Safety Committee: This course gives credit to members for service on this committee. Credit is given at the completion of each year of service.

Radiation Special Seminar: This course includes seminars, talks, lectures and question and answer sessions about requested topics in radiation and radiation safety.

Radiation Safety Train the Trainer: This course is designed to review specific radiation safety requirements of authorization and use of radioactive materials. The AU should be in attendance at this type of training.

Radiation Safe Handling Workshop: This course is designed especially for AU's and RW's at MU. This course includes basics of radiation safety, measurements, radiation biology, protection guides and regulations. Half of the contact hours involve laboratory procedures using radioisotopes and detection techniques.

See the EHS webpage for schedule of Radiation Safety courses. Contact the RS Office at 882-7221 to specifically schedule any one of these training programs for your group. Also, contact the RS Office to discuss the development of a specific training course.

EMERGENCY RESPONSE

GENERAL

The RS Office provides standby emergency response capabilities for use in situations where you cannot properly respond to a radioactive material situation or you feel uncomfortable with a potential radiation emergency.

An emergency call list is available with the MU Police Department and the University of Missouri Healthcare, which will allow them to contact a member of the RSS during non-working hours and put them in touch with the person requesting help.

Should an emergency arise during working hours, contact your assigned Health Physicist or if not available, state your problem to one of our office staff members and they can connect you with someone who can lend assistance.

EMERGENCY PROCEDURES

During working hours contact the RS Office at 882-7221 for assistance. Make sure you give the receptionist a clear message regarding the nature of the problem. If you know your assigned HP, you may try to contact that person first.

MU Police will contact RSS members after hours for response to a radiation emergency situation. Therefore after hours contact MU Police first at 882-7201 so that they can contact one of the RSS members. If the emergency only involves radioactive material, make sure that you indicate this to the MU Police dispatcher so that they will use the appropriate call list. There is also a Hazardous Materials call list for situations involving chemical spills.

Refer to the Radiation Emergency Procedures for more details concerning your response.

INSTRUMENT CALIBRATIONS

GENERAL

The RS Office provides survey meter calibrations for AU's free of charge. Survey meters are calibrated annually or upon repair.

The AU is responsible for replacing batteries and for any repairs on the instruments.

A list of your current active survey meters, Liquid Scintillation, and other counting equipment is available for you to see during routine quarterly inspections, and is printed on the quarterly reports. You should report any discrepancies to your assigned HP.

CALIBRATED INSTRUMENTS

For Liquid Scintillation, the RSS performs efficiency checks on the instrument for the particular protocol and isotope that you use in performance of swipe surveys. On some counters it is possible to set up and use multiple protocols to accommodate the needs of different AU's who may be using different isotopes.

Portable survey instruments probe efficiencies are determined for different isotopes to help estimate contamination levels when the isotope is known or suspected (i.e., surface reading with the probe face at 1 cm).

If you have any questions regarding the operation of your instrumentation, you can contact your assigned HP or another member of the RSS, and they will be glad to assist you.

NUCLEAR REGULATORY COMMISSION PERIODIC INSPECTIONS

GENERAL

The Nuclear Regulatory Commission periodically performs inspections at MU to ensure compliance with NRC rules and regulations. The inspection helps to assure that MU meets its regulatory obligations through adherence with its license conditions and any other agreements which may have been mutually agreed upon by the two parties. Generally, when an NRC inspector calls on you in your laboratory, they will ask many of the same questions and review much of the same paperwork which the RSS looks at during a quarterly inspection. You should cooperate with the NRC inspector as you would with any EHS inspector.

ITEMS WHICH MAY BE REVIEWED

- Records of radioactive materials receipt, use, and disposal. This includes waste pickups and transfers.
- Training records for persons authorized to work unsupervised in the lab.
- Documentation of periodic surveys. This includes your swipe and meter readings along with any decontamination efforts performed.
- Proper operation of hoods, survey instruments and other radiation counting instrumentation.
- Proper posting of areas, NRC Form 3, Radiation Emergency Procedures, etc.
- Performance based appraisals based on your ability to perform a radiation safety function properly.

ROUTINE INSPECTIONS BY THE RADIATION SAFETY OFFICE

GENERAL

The RS Office performs routine inspections of each of the AU's on campus.

The purpose is to review records, to perform contamination checks, to ensure that radiation safety equipment is operational, to verify that the lab posting and labeling is current and appropriate, and in general, to advise the AU and RW's on compliance issues.

The purpose of these inspections is not punitive in nature, but they are designed to ensure that you will pass any inspection which occurs if NRC inspectors appear in your laboratory.

In some cases, authorized areas are inspected more frequently, such as nuclear medicine which is inspected monthly.

Authorizations which exhibit problems regarding certain compliance issues may also require increased inspection frequencies.

ITEMS FOR REVIEW

- Records of radioactive materials receipt, use, and disposal. This includes waste pickup and transfers.
- Training records for persons authorized to work unsupervised in the lab.
- Documentation of periodic surveys. This includes your swipe and meter readings along with any decontamination efforts performed.
- Proper operation of survey instruments, and other radiation counting instrumentation.
- Proper posting of areas, NRC Form 3, Radiation Emergency Procedures, etc.
- Performance based appraisals based on your ability to perform a radiation safety function properly.

RADIOACTIVE MATERIAL ORDERING AND DELIVERY

GENERAL

Once you have received your authorization to possess radioactive material and have obtained a Job/Order number to order the material, it is time to place your order. Once you place your order with the vendor, you must call or fax EHS to notify them of the impending delivery. This assists RSS in scheduling your delivery upon receipt of the package and in meeting the necessary regulatory requirements for receipt of radioactive materials. The following information will be required to process your order.

INFORMATION REQUIRED

Use the Notification of Radioactive Material Order form to provide the following information:

- AU name,
- Person submitting the information,
- Phone number where the person can be reached if additional information is required,
- Location radioactive material is to be delivered (must be authorized for these areas),
- Isotope and activity ordered,
- Vendor, and
- Expected arrival date.

Once the package arrives, the RSS fills out the paperwork required for DOT purposes, performs any radiological measurements as required by regulations, and delivers the package to your place of work. Once you receive the package, be sure to survey the empty package prior to disposal and remove or deface any information related to radioactive content. You must use the check off box on your receipt form to document that this has been performed.

WHAT HAPPENS AT EHS AFTER YOU SUBMIT YOUR REQUEST FOR A RADWASTE PICKUP

GENERAL

Upon arrival at our office your request for a radioactive waste pickup is sent to our waste handling personnel, so that we can schedule it into our pickup schedule.

EHS PICKUP

Once we have verified the appropriate information has been submitted, your request will then be scheduled for pickup at the next available time.

Should you need a special pickup, please notify your assigned HP so that one can be arranged.

Once the waste has been picked up and sent to its intermediate destination at EHS it is entered into the database. If you are subtracting out too much inventory, i.e., more that you have in stock, use, etc., an error will occur and you will be notified by your assigned HP. This is why we need you to decay and estimate as accurately as possible the radwaste amount that you wish to be picked up.

You will have a chance to correct any information submitted during the quarterly report review period. This will allow you to correct, add, or delete any information which was erroneously entered into your activity account.

Upon segregation at EHS into mixed, liquid or solid wastes, the radwaste is stored until a sufficient quantity can be accumulated for further processing (i.e., decayed in storage, shipped as radioactive waste, or mixed waste.)

EHS MANAGEMENT AND DISPOSAL OF RADWASTE

Solid Radwaste (Dry)

Depending on the isotope, the solid waste will be shipped to a licensed burial site, held at EHS facilities for decay to background levels or incinerated.

Solids that contain a hazardous component are considered mixed waste. They are placed in the EHS hazardous waste facility, and ultimately shipped to a permitted facility for disposal.

Liquid Radwaste

Liquid radwaste that does not contain a hazardous component (as defined by EPA RCRA regulations) will be disposed of in accordance with NRC regulations to the sanitary sewer. Isotopes that have half lives shorter than 120 days are held to decay for a period of time prior to final survey and disposal.

Liquids that contain a hazardous component, and cannot be decayed to background levels, are considered mixed waste. They are placed in the EHS hazardous waste facility, and ultimately shipped to a permitted facility for disposal.

Scintillation Vials and Animal Carcasses

Scintillation vials containing H-3 and C-14 are incinerated in the EHS incinerator. Isotopes with half lives less than 120 days are incinerated after a decay period of at least 10 half lives.

Animal carcasses or tissue are held for decay, if possible, and then incinerated.

Scintillation cocktail and animal tissues containing H-3 or C-14 in concentrations of equal to or less than 0.05 microCuries/g of material can be disposed of as if they did not contain radioactive materials. Only EHS staff can make this type of disposal. Availability of this disposal option is why it is very important to have a reasonable estimate of activities for H-3 and C-14 in these forms.

Scintillation vials, animal carcasses and tissues that contain a hazardous component, and cannot be decayed to background levels, are considered mixed waste, and they are placed in the EHS hazardous waste facility, and ultimately shipped to a permitted facility for disposal.

Scintillation vials, and animal carcasses and tissue with isotopes greater than 120 day half life are shipped off-site to a radwaste facility for further processing and disposal.

Stock Items, Stock Containers, and Shielding

Stock vials are kept separate for decay in storage and final survey.

The stock containers are inspected to determine if they have lead shielding. Containers not containing lead are surveyed and, if clean, may be disposed of as normal trash or reused. Containers containing lead are surveyed and, if clean, they may be reused or recycled.

Sealed Sources, Foils, and Seeds

Unwanted sealed sources, foils, and seeds with half lives less than 120 days are held for decay of at least 10 half lives and then disposed as normal trash.

Every effort is made to return unwanted sealed sources, foils, and seeds with half lives greater than 120 days to their manufacturer. Otherwise, they are shipped off-site to a radwaste facility for further processing and disposal.

REFERENCES

10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations"

10 CFR Part 20, "Standards for Protection Against Radiation"

10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"

10 CFR Part 33, "Specific Domestic Licenses of Broad Scope for Byproduct Material"

10 CFR Part 35, "Medical Use of Byproduct Material"

10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions"

10 CFR Part 71, "Packaging and Transportation of Radioactive Material"

19 CSR 20, "Radiation Protection" Missouri Department of Health and Senior Services

NUREG 1556, Vol. 7 "Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope Including Gas Chromatographs and X-Ray Fluorescence Analyzers"

NUREG 1556, Vol. 9, Rev. 2 "Program-Specific Guidance About Medical Use Licenses"

NUREG 1556, Vol. 11 "Program-Specific Guidance About Licenses of Broad Scope "

MU Materials License Application, June 16, 2003.

MU Materials License, Amendment #108, February 4th, 2011.

Regulatory Guide 8.29, "Instructions Concerning Risks for Occupational Radiation Exposure"

Regulatory Guide 8.13, "Instruction Concerning Prenatal Exposure"

Radiation Safety Web Page:
http://ehs.missouri.edu/rad

Biosafety Manual, September 2004