RADIOLOGICAL SAFETY PROGRAM MANUAL

Radiological Safety
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INTRODUCTION

The radiological safety program at Texas A&M University exists to protect employees, students, and visitors as well as the public and the environment from the harmful effects of exposure to ionizing and nonionizing radiations. The University is committed to meeting all applicable regulatory requirements imposed by the State of Texas or the United States government and to keeping doses from licensed sources of radiation As Low As Reasonably Achievable (ALARA) - social, technological and economic factors taken into account.

This Procedure Manual has been approved by the Texas A&M University Radiological Safety Committee (RSC) and Radiation Control, Texas Department of State Health Services (DSHS), and is issued and maintained by the Texas A&M University Environmental Health and Safety Department (EHSD). It is divided into three separate and independent parts:

Part One: Procedure Manual for the Use of Radioactive Materials

Part Two: Procedure Manual for the Use of Radiation Producing Devices

Part Three: Procedure Manual for the Use of Lasers

Laboratory Procedure Manuals which contain radiation safety related procedures and guides for use by laboratory personnel are printed as separate manuals and are available from the EHSD upon request.

The rules, responsibilities, and procedures which comprise the Texas A&M University radiation safety program also apply to those Texas A&M University System personnel and operations authorized in a license or by registration issued to Texas A&M University and administered by the TAMU EHSD.

PART ONE

PROCEDURE MANUAL FOR THE USE OF RADIOACTIVE MATERIALS

PART ONE
TABLE OF CONTENTS

SECTION 1

PURPOSE AND SCOPE

The purpose of this manual is to establish the requirements for the use of licensed radioactive materials at Texas A&M University, in any physical or chemical form. The provisions contained in Part One do not apply to radiation producing devices (x-ray machines, accelerators, etc.) or lasers. Separate Parts of the Radiological Safety Program Manual are dedicated to each. This manual also does not apply to radioactive sources, which are issued and maintained under a General License, or General License Acknowledgment issued by the USNRC or the State of Texas.

Part One of this manual is intended for persons applying for or holding a Permit for the use of radioactive materials. Such Permits are issued by Texas A&M University under authority granted to the University by the State of Texas or by the United States Government. Permit holders must conform to all applicable regulations and to any conditions placed on the applicable license. Conditions may include, but are not limited to, restrictions on radionuclides, quantity (radioactivity), location of work, and type of experiments authorized. Following is a list of radioactive material licenses issued to Texas A&M University.

License Number	Issuing Agency
L00448	Texas Department of Health, Bureau of Radiation Control
L05683	Texas Department of Health, Bureau of Radiation Control
42-09082-09	United States Nuclear Regulatory Commission

Current versions of each of these licenses are available through the TAMU Environmental Health and Safety Department (EHSD).

SECTION 2

ORGANIZATION AND RESPONSIBILITIES

A. Radiological Safety Committee (RSC)

The RSC advises the Texas A&M University administration on matters related to radiation safety and recommends policies and procedures it deems appropriate to ensure an adequate radiation safety program.

1. The RSC consists of at least six voting members, including the Chair, appointed by the Executive Vice President and Provost (Provost) plus three Ex Officio (non-voting) members:
    a. Director, Environmental Health and Safety Department
    b. Radiological Safety Officer (RSO)
    c. Vice President for Risk and Compliance
2. RSC membership should include representatives from each of the colleges where use of radiation is common.
3. A quorum shall consist of 50% or more of the voting members.
4. The RSC shall meet at least three times annually and upon request of the Committee Chair. The RSO or designee shall brief the RSC on the status of the radiation safety program, including
    a. changes in radiation safety staff and organizational structure
    b. changes in regulations
    c. review of incidents and emergencies
    d. proposed field research protocols
    e. review of procedural changes
    f. radiation safety program operations, including future needs and requirements.

5. Specific responsibilities of the RSC include
    a. reviewing and approving applications for possession and use of radioactive materials.
    b. notifying and advising the Provost of any event which results in a violation of Severity Level I or II as defined in Texas Department of State Health Services rules or any violation of federal regulations which might result in imposition of fines or penalties. Such notifications should include a description of any subsequent corrective actions taken by the RSC.
    c. reviewing field study proposals wherein radioactive materials will be intentionally released, either directly or indirectly, into the environment.
    d. serving as the appeals board for persons
        i. desiring relief from radiation safety program or RSC policies or requirements,
        ii. desiring that a request for exemption from state or federal regulations be submitted to the regulatory agency on their behalf
        iii. desiring to resume work or activities which were halted under a "stop work order" issued by the staff of the radiation safety program.
    e. reviewing or auditing radiation safety program operations at the EHSD annually.

B. <u>EHSD Radiation Safety Staff (RSS)</u>

The EHSD RSS is responsible for surveillance of all uses of radioactive materials which are authorized under any of the licenses listed in the Section 1, "Purpose and Scope". Specifically, the RSS shall be responsible for:

1. applying for new or maintaining existing licenses required by state and federal agencies to support the use of radioactive material in teaching or research and development

2. maintaining a personnel dosimetry program, including evaluating the need for issuance of dosimetry, maintaining a contract for commercial dosimetry services, maintaining dose records, and providing reports to individuals as per regulations
3. reviewing applications for Permits to use radioactive material prior to submitting the application to the RSC
4. maintaining Permit records including approved applications, amendments, and renewals
5. performing receipt inspections of radioactive material shipments
6. packaging radioactive materials for transport
7. maintaining inventories of radioactive materials
8. performing routine inspections of Permitted Users
9. disposing of radioactive materials
10. providing support in the event of an incident or emergency and reporting same to the appropriate regulatory agency, as appropriate
11. leak testing of sealed sources
12. calibrating portable survey instruments
13. providing radiation safety training for university personnel
14. providing information and consultation on matters related to radiation safety

C. Radiological Safety Officer (RSO)

The RSO is charged by the University to direct the radiation safety program for Texas A&M University and supported Texas A&M University System agencies. Specifically, the RSO shall:

1. serve as an ex-officio member of the RSC
2. direct the operations of the RSS
3. advise University personnel on matters related to radiation safety
4. advise University administration on matters related to radiation safety
5. be empowered to impose conditions of work, restrictions on work, and termination of work involving sources of radiation as necessary to protect University personnel, the public, or the environment or to ensure regulatory compliance
6. review the radiological safety program at least annually

7. serve as the University's point of contact with state and federal regulatory agencies on all matters related to radiation safety

D. Permit Holder (Permittee)

The Permit Holder is at all times responsible for all radioactive materials which he or she possesses and for all operations in his or her laboratory which involve radioactive materials. This responsibility extends to the actions of all employees, students and visitors who enter the Permittee's radioactive material work area. Furthermore, Permittees should only undertake those uses of radioactive materials which are reasonably expected to yield benefits that outweigh the risks associated with that use of radioactive material. Specifically, Permittees shall:

1. ensure that all activities involving licensed sources of radiation are authorized under the Permit, as amended
2. ensure that radioactive materials are secured from unauthorized removal or access
3. maintain an accurate list of employees and students authorized to work with radioactive materials
4. develop and maintain written procedures/protocols involving radioactive materials
5. ensure that laboratory personnel receive EHSD-approved
   1. General Radiological Safety (initial and refresher) and,
   2. Laboratory Specific training

   before being authorized to work unsupervised with radioactive material
6. ensure that laboratory personnel complete refresher training required by the EHSD
7. ensure that exposures to ionizing radiation and releases of radioactive materials are maintained As Low As Reasonably Achievable (ALARA)
8. conduct and document surveys for radiation levels and/or contamination in accordance with Section 7 of this Part
9. inform the EHSD, in writing, if extended leave (28 calendar days or more away from the normal work location) is planned. The written notification is required at least 30 calendar days in advance of departure.
10. notify EHSD immediately in cases of

a. personnel contamination
b. lab contamination
c. high doses (known or suspected) to any person
d. intake of radioactive materials by any person (known or suspected)
e. deceptive or false exposure of personnel dosimetry (known or suspected)
f. alleged or known violations of the rules prescribed in this document or of the applicable rules of the State of Texas

11. conform to any conditions placed on the Permit by the EHSD or RSC
12. comply with the provisions of this manual and the Radionuclide Laboratory Procedure Manual

E. The Individual

Each employee or student of the Texas A&M University System who works with radioactive material under a license listed in Section 3 of this manual must take responsibility for their own protection and for reporting any condition which, in the individual's opinion, constitutes unsafe or improper working conditions. Each individual is responsible for:

1. maintaining their own exposures to radiation and radioactive materials ALARA
2. following procedures and accepted safe work practices so as not to endanger themselves, the public, or the environment
3. reporting any unsafe working conditions, violations of the rules prescribed in this document, or violations of the applicable regulations of the State of Texas to their supervisor and/or to the TAMU EHSD

SECTION 3

LICENSING REQUIREMENTS AND REGULATIONS

A. University Licenses

1. The primary license, license number L00448, is a specific license with broad-scope authorizations and is typical of large medical and academic institutions which have many Permitted Users and widely varied uses for radioactive materials. This license is issued by Radiation Control, a unit of the Texas Department of State Health Services (DSHS).License L00448 authorizes radioactive material use in College Station and Galveston.
2. The remote site license, license number L05683, is a specific license primarily for moisture gauge users and some open isotope work at Prairie View A&M University and at Texas Agricultural Experiment Station sites around the State of Texas. This license is issued by Radiation Control, a unit of the Texas Department of State Health Services (DSHS).
3. License number 42-09082-09, issued to Texas A&M University by the United States Nuclear Regulatory Commission (USNRC), authorizes TAMUS Permittees to possess and use limited activities of certain radionuclides at sea and anywhere the USNRC maintains jurisdiction. This license is used primarily by Permitted Users who wish to use radioactive materials aboard research vessels traveling beyond the state waters of Texas (The Texas Territorial Sea is that portion of the Gulf of Mexico extending seaward from Texas' Gulf shoreline out to nine nautical miles. - Texas Parks and Wildlife Department).
4. A Permitted User at TAMUS may occasionally find that the licenses listed above do not allow the use of radionuclides in a quantity, location or manner desired by the researcher. Amendments to these licenses may be requested by any Permitted User by submitting such a request to the EHSD. Depending upon the request, the EHSD may or may not agree to submit a request to the appropriate licensing agency. If not, the Permitted User may appeal that decision to the Radiological Safety Committee.

5. A copy of the latest version of any license may be obtained from the EHSD.

B. Authorization to Use Radioactive Materials

1. Any faculty or staff member in the Texas A&M University System may apply for a permit to use radioactive materials. This person must be in position of authority over laboratory personnel and operations. Application forms are available from the EHSD.
2. A Permit is issued to one person, never to a group, department, or facility.
3. Permits for radioactive material use are not transferable.
4. Permits are only valid for two years. At least 30 days prior to the end of the two year period, the EHSD shall notify the Permittee, in writing, of the need for renewal.
5. A second and final notice shall be sent to Permittees not responding to the first notice.
6. Failure to respond within 14 days of the date of the second notice shall be cause for the EHSD to send written notice to the Permittee that his/her Permit has been terminated requiring cessation of all work previously authorized under the Permit and confiscation of all radioactive materials covered by the expired Permit. Exceptions may be granted by the RSO where circumstances warrant.
7. Requests for renewal shall be submitted to the EHSD, in writing, signed by the Permittee. Properly signed copies received by fax are acceptable.
8. The RSO or the RSC may at any time place additional conditions or restrictions on a Permit for reasons of safety and/or compliance.
9. Only work which is authorized under the applicable Permit may be performed. The Permit may include restrictions or limits on
    a. radionuclide(s) authorized for possession/use
    b. activity per radionuclide
    c. chemical or physical form of each the radionuclide
    d. location of use and/or storage of radioactive materials
    e. types of experiments authorized
10. Radioactive materials shall not be used in or on humans.

11. Radioactive materials shall not be released to the environment unless specifically authorized in writing by the RSO.

C. Application for Permit to Use Radioactive Materials

1. Applicants shall complete and submit two copies of the application form, "Application for a Permit for the Use of Radioactive Material at Texas A&M University," each bearing an original signature of the applicant.
2. The EHSD and the RSC shall review the application for the following
   a. location - applicant's proposed use/storage location(s) must be authorized under an appropriate University license.
   b. position and authority of applicant - Permitted Users must have sufficient authority to control the use of the radioactive materials authorized. That is, a subordinate should not be the Permitted User if that person's supervisor is to be designated as a user on the application.
   c. radionuclides, activities, and form - should be consistent with the "statement of use"
   d. statement of use - list or categorize the experiments in which radioactive materials are to be used. Describe in detail if toxic compounds will be used or if volatile materials will be involved. Are releases of radioactive materials possible? Are extra precautions warranted? Will mixed (hazardous and radioactive) waste be generated?
   e. handling and storage procedures - should be consistent with the level of hazard associated with the radionuclides, activities and intended uses
   f. radiation safety training - applicants shall be required to demonstrate or verify that they have a minimum of 40 hours of combined training and experience in the use of radioactive materials. Applicants wishing to be authorized to use radioactive materials in clinical veterinary medicine shall demonstrate that they are certified by the American College of Veterinary Radiology (ACVR) or have completed a combination of course work and experience equivalent to the guidelines specified by the ACVR for residency programs. In addition, all applicants and each person who

uses or supervises the use of radioactive materials (Item No. 3 on application) shall be required to satisfactorily complete EHSD-approved training in radiation safety before beginning unsupervised work with radioactive materials. Satisfactory completion of training shall be determined by achieving a grade of at least 70% on a test administered or approved by the EHSD.

g. survey instrumentation - each applicant must possess instrumentation appropriate for monitoring radiations from the radionuclides and quantities requested (Permit will not be issued until instrumentation is in the lab)
    i. for beta/gamma emitters except H-3 and I-125 - Geiger-Mueller (GM) survey meter with a thin window
    ii. for H-3 - access to a liquid scintillation counter
    iii. for sub-millicurie quantities of I-125 - access to a liquid scintillation counter or a solid scintillator (e.g. a NaI well counter)
    iv. for millicurie quantities of I-125 - a portable, thin-window NaI detector
    v. exceptions to this requirement include applicants requesting possession of gas chromatographs with Ni-63 foil sources. Other exceptions may be granted if approved by the RSO and the RSC.
h. facilities - must be adequate for the radionuclides and quantities requested
    i. occupancy of adjacent or adjoining spaces
    ii. availability of shielding and/or remote handling equipment, as appropriate
    iii. availability of appropriate fume hoods
    iv. availability of drains connected to the sanitary sewer
    v. potentially conflicting uses of laboratory space
    vi. locations of radionuclide use and storage (including waste storage)
i. security - radioactive materials shall be secured against unauthorized removal or access. Describe how security will be maintained in your

laboratory including radioactive materials in storage, radioactive materials in a protocol which is in-progress, and radioactive waste.

3. Reviewed applications, along with EHSD recommendations, shall be forwarded to three RSC members for review and approval. Approval is contingent upon written approval by all three RSC members. Unless directed otherwise by the RSC Chair, EHSD staff shall select three RSC members to review the application based upon the expertise and availability of the members.
4. If the application is denied, the EHSD shall contact the applicant with information regarding the reasons for denial. At the applicant's discretion, he/she may revise the Permit application to meet the inadequacies or criticisms and resubmit the application.

D. Amendments to Permits

1. A request for an amendment to a Permit shall be submitted in writing (letter, memorandum, or e-mail) to the EHSD.
2. Permit amendments are required for changes in
   a. authorized radionuclides,
   b. possession quantity limits of any radionuclide,
   c. physical or chemical form of the radionuclide,
   c. storage or use location,
   d. type of experiment, or
   e. any other condition or restriction placed upon the Permit by the EHSD or the RSC.
3. Amendment requests which involve significant changes to the Permit shall require written approval of a subcommittee of three of the RSC.

E. Termination of Permits

1. Permittees in College Station, Texas who intend to terminate a Permit shall notify the EHSD, in writing, at least 30 calendar days prior to leaving, moving, or relinquishing control of the licensed facility.

2. Prior to terminating a Permit, Permittees shall transfer licensed materials in their possession to a TAMUS Permittee (approved by the EHSD), to another non-TAMUS licensee (approved by the EHSD), or to the EHSD for disposal.
3. Disposal costs may be the responsibility of the Permittee or his/her department. Contact the EHSD for further information.

F. Termination of Permits for Cause

1. An inactive Permittee (defined in a. and b. below) may be notified in writing that their Permit will be terminated unless they provide written justification, co-signed by the appropriate department head, for maintaining an active Permit. A Permittee who has been terminated because of inactivity may reapply for a Permit at any time. Inactive Permittees are defined as
   a. users of unsealed sources that have not received radioactive materials and/or disposed of radioactive wastes within the preceding two years.
   b. Users of sealed sources whose sources have not been used (as determined through the inspection process) within the preceding two years.
2. Any Permittee who willfully and/or negligently violates any applicable University, State, or Federal regulation governing the use of radionuclides as determined by the RSO shall have their Permit modified, suspended, or revoked. Radionuclides in their possession shall be impounded by the EHSD.
3. Reinstatement of a Permit following suspension or revocation shall require approval by a two-thirds majority of all voting members of the RSC.

G. Sabbaticals and Absences (28 calendar days or greater)

Permittees shall notify the EHSD at least30 calendar days prior to the beginning of the sabbatical or extended leave. The Permittee shall

1. arrange for another Permittee to oversee ongoing operations and records keeping and be available to laboratory personnel for routine or emergency assistance. Documentation shall be required by the EHSD.

   - OR -

2. transfer all radioactive materials to the EHSD for disposal. The EHSD may store radioactive materials for the Permittee, if storage space is available.

SECTION 4

PROCUREMENT, TRANSFER, DISPOSAL, AND INVENTORY OF RADIONUCLIDES

Radioactive materials must be tracked from receipt at TAMUS to final disposal. Accurate inventories and thorough documentation are fundamental controls necessary for TAMUS to demonstrate compliance with state and federal regulations.

A. Procurement of Radionuclides

Each Permittee is responsible for ordering radionuclides directly from the vendor. Some departments may establish a centralized procurement system, but each Permittee shall be responsible for ensuring that EHSD procedures for procurement of radioactive materials are followed (refer to the Radionuclide Laboratory Procedure Manual).

1. Prior to ordering radionuclides, the Permittee or a designee shall obtain EHSD approval to place the order (by computer database, fax, telephone, or by routing purchase requisitions through EHSD for approval).
2. When placing orders, ensure that the "bill to" address is appropriate for the source of funds (never EHSD) but the "ship to" address given to the vendor is the address of the EHSD **but sent to your (the Permittee's) attention.**
3. Radioactive materials may be delivered to destinations other than the EHSD only in the following cases
   a. the Permittee is permanently located at an authorized site not on the TAMU main campus (includes all locations in Bryan/College Station), i.e., Prairie View A&M University, TAES remote facilities, etc.; and/or
   b. the Permittee has made prior arrangements with the EHSD.

B. Receipt of Radionuclide Shipments

In this section, the term "shipment", applies to receipt of any licensed radioactive materials whether they are purchased from a commercial vendor, loaned by a colleague from another institution, or otherwise brought onto the TAMU main campus in College Station.

1. All incoming shipments of licensed radioactive material must be received, inspected, and inventoried according to EHSD procedures.
2. Receipt inspection procedures for Permittees at authorized sites not on the TAMU main campus may be found in the Radionuclide Laboratory Procedure Manual, available from the EHSD. Receipt forms shall be maintained on-file by remote site Permittees for the life of the Permit.
3. Radioactive materials received at the EHSD shall normally be delivered to the Permittee's laboratory the same day, if laboratory personnel are available to acknowledge receipt.
4. Radioactive material shall be delivered to laboratories, not to departmental offices.
5. Deliveries to the EHSD on weekends and on TAMUS holidays are prohibited. Exceptions in special cases may be granted with prior approval of the EHSD.

C. Inventory of Radionuclides

1. Each Permittee shall maintain accurate inventory records at all times.
2. The EHSD shall send a printout of the radioactive material inventory to each Permittee, typically once each six months. These inventories shall include those radioactive materials that the Permittee has discarded as waste, but has not been collected by the EHSD (includes all radioactive material in facility, regardless of location).
3. The Permittee, or designee, shall physically locate each item on that inventory, sign and date the inventory, return the inventory bearing the original signature, and keep a copy for the Permittee's records until superseded.
4. Discrepancies between the printed inventory (undecayed) from the EHSD and the radionuclides on-hand shall be noted by the Permittee, explained in writing and via supporting documentation (if available), and returned to the EHSD with the inventory records.

D. Transfers of Radioactive Materials

"Transfer" of radioactive material, as used in this section, does not include transfer of radioactive materials to the EHSD for disposal. "Transfer" refers to a change in custody

or control of radioactive material even if there is no change in ownership. An example would be a transfer of C-14 from one Permit Holder at TAMU to another, or to another institution, such as UT-Austin.

1. Transfers require prior EHSD approval.
2. Transfer procedures are provided in the Radionuclide Laboratory Procedure Manual.

E. Disposal of Radioactive Materials

1. No Permittee may dispose of radioactive materials except
   a. by transfer to the EHSD, or
   b. as specifically authorized by the EHSD
2. All Permittees are hereby authorized to wash contaminated glassware, lab coats, etc. and discharge the rinse water to the sanitary sewer system. No radioactive materials, including those in rinse water may be discharged into any drain which is not connected to a sanitary sewer system. A septic tank is not a sanitary sewer.
3. All radioactive waste containers (carboys, bags, trash cans, etc.) shall be conspicuously marked as containing radioactive material. Labels with the smallest dimension being less than 2 inches will not normally be adequate.
4. Procedures for requesting waste collections, for proper segregation and packaging of radioactive wastes, and for documentation of radioactive waste disposals are provided in the Radionuclide Laboratory Procedure Manual.
5. Disposal documentation must be maintained on-file for the 1 year after final disposal for laboratories located on the TAMU campus in College Station and for the life of the permit if the lab is located at a remote site.

SECTION 5

CONTROL AND LIMITATION OF RADIATION EXPOSURES

The effects of chronic low doses of radiation (in the range of 0 - 5 rem per year), as typically received by occupationally exposed persons, are not well known. Conversely, acute high doses of radiation (>100 rem in one exposure) are known to increase the risk of stochastic effects such as cancer in the exposed individual or genetic effects in the progeny of the individual. By extrapolating the dose-effect relationship from high doses to low doses using the linear nonthreshold theory, increased risks for stochastic effects can be estimated even for very low radiation doses. (Reference USNRC Regulatory Guide 8.29)

These data and models lead to the conclusion that there is no dose which is one hundred percent "safe", i.e., completely without risk. However, natural and man-made background radiation is ubiquitous, providing an average annual radiation dose of 0.360 rem to every U.S. citizen. Large fluctuations in background radiation, by geographical location, have not been shown to result in any measurable increase in risk of any health effect. Nevertheless, any radiation dose received occupationally will be in excess of the background radiation dose received and will be assumed to carry with it additive risk of deleterious effect.

State and federal regulations therefore establish a system of dose **limitation** and **minimization**. Individual doses are **limited** to ensure that deterministic effects (such as cataracts) are avoided and that total lifetime risks of stochastic effects (such as cancer and hereditary effects) do not exceed overall health risks for those persons working in safe industries. However, regulations also require that licensees further **minimize** radiation doses to individuals and to groups of individuals to the extent practical, social, economic and technological factors taken into account. This concept or philosophy is given the special name ALARA which is an acronym for As Low As is Reasonably Achievable.

A. Radiation Dose Limits

1. Occupationally Exposed Adults:
   a. Total Effective Dose Equivalent (TEDE) - 5 rem/y (5,000 mrem/y)
   b. Total Organ Dose Equivalent (TODE) - 50 rem/y (50,000 mrem/y)
   c. Shallow Dose Equivalent (SDE) -50 rem/y (50,000 mrem/y)
   d. Extremity Dose Equivalent -50 rem/y (50,000 mrem/y)
   e. Lens (of Eye) Dose Equivalent (LDE) - 15 rem/y (15,000 mrem/y)
2. Individual Members of the Public
   a. 2 mrem in any one hour
   b. Total Effective Dose Equivalent (TEDE) - 0.1 rem/y (100 mrem/y)
3. Occupational Dose Limits for Minors (under 18 years of age) *
   a. Ten percent (1/10) of any applicable limit in item 1 above
4. Dose to an Embryo/Fetus of a Declared Pregnant Woman **
   a. Total Effective Dose Equivalent (TEDE) – 0.500 -rem over entire pregnancy
   b. TEDE should not vary substantially above 0.050 rem in any month

* In accordance with State and Federal Child Labor Laws, TAMU **will not employ** persons under the age of 18 years as radiation workers.

** Accomodations for Declared Pregnant Women (see definitions) should be made when possible to reduce doses to the unborn. Contact EHSD for assistance.

B. Routes of Exposure and Means of Exposure Control

Exposures may be received from radioactive materials which are external to the body (external exposure) or from radioactive materials which are inside the body (internal exposure) or both.

1. Control of External Exposure

   Common external exposure controls include the use of time, distance, and shielding to minimize radiation doses. These concepts are thoroughly presented in EHSD radiation safety training courses but should also be continually

reinforced by the Permitted User in the laboratory. In addition, doses may also be reduced by minimizing the amount of radioactive materials on-hand (e.g., procure only the amount needed) or by substituting for radioactive materials (e.g., use P-33 instead of P-32 or use nonradioactive tracer techniques).

2. Control of Internal Exposure

The only reasonable method by which internal exposures can be controlled or minimized is by preventing the intake of radioactive materials. The four routes by which radioactive materials can be taken into the body are 1) inhalation, 2) ingestion, 3) absorption through the skin, and 4) injection through wounds. To protect against these routes of intake, Permitted Users are expected to utilize good laboratory safety practices as identified in the Radionuclide Laboratory Procedure Manual. Of particular importance are the following:

a. use of a properly functioning fume hood which is suitable for use of radioactive materials - particularly when using volatile radioactive compounds (those which could reasonably become airborne).

b. no smoking, eating or drinking in a laboratory in which radioactive materials (other than sealed sources) are used or stored. This includes smokeless tobacco and chewing gum. Furthermore, food, drinks, eating utensils, cups, drinking glasses, etc. shall not be used or stored in rooms or refrigerators where use of radioactive material is authorized. Microwave ovens and ice machines in laboratories are not for personal uses.

c. wear protective clothing, including gloves and closed-toe shoes. Laboratory coats are required when using activities greater than 50 microcuries (remember to protect legs by wearing leg coverings or a long lab coat). Laboratory coats and eye protection are recommended at any level.

d. Required precautions and contamination prevention techniques are prescribed in the Radionuclide Laboratory Procedure Manual.

SECTION 6

RADIATION DOSIMETRY

The purpose of the radiation dosimetry program is to measure radiation dose equivalent received by occupationally exposed individuals at TAMUS. The results serve to verify and document compliance with the applicable dose limits (see Section 5) as well as to identify problems and monitor the effectiveness of existing radiation safety controls.

Radiation doses may be received in two ways: 1) from radioactive materials which are external to the body (external dose) or 2) from radioactive materials which are inside of the body (internal dose). These doses shall be monitored when required by regulation, as described below:

A. External Radiation Dosimetry

1. Radiation dosimeters appropriate for the radiations to be monitored shall be issued by the EHSD to the individual and shall be required to be worn (with the name facing outward) by
    a. adults, minors and declared pregnant women likely to receive, in one year from sources external to the body, a dose in excess of 10% of the applicable dose limits (ref. Section 5); and
    b. individuals entering a High Radiation Area or a Very High Radiation Area.
2. The EHSD shall determine the "likely to exceed 10%" status of an individual (ref. 1.a above), the dosimeter type, the wear period, etc. Dosimeters are generally incapable of monitoring doses from low energy (E_{max} less than 200 keV) beta emitters such as H-3, C-14, S-35 and Ni-63.
3. The Permittee shall immediately notify the EHSD of changes in radioactive materials uses that could significantly increase or decrease radiation doses to laboratory personnel or which could otherwise affect the need for external dosimetry.
4. Radiation dosimeters shall not be issued for wear periods greater than 3 months.

5. Radiation dosimeters shall not be deceptively exposed.
    a. Dosimeters are issued to only one person. Dosimeters shall not be shared.
    b. Dosimeters in storage and not being worn shall not be stored near sources of radiation.
    c. Dosimeters should not be exposed to high heat, chemical or physical insults, or washed in a washing machine.
    d. No person shall wear dosimeters issued by the TAMU EHSD while working for another employer or institution without prior approval from the EHSD. Permittees shall notify the EHSD if employees are concurrently working for another (non-TAMUS) employer and working with sources of ionizing radiation.
    e. Dosimeters shall not be worn during medical or dental x-ray examinations.
    f. Dosimeters shall not be worn after medical administration of radioactive materials (thyroid ablation therapy, cardiac stress tests, diagnostic nuclear medicine tests, etc.) until approved by the TAMU EHSD.
    g. Permittees shall notify the EHSD immediately upon learning of possible deceptive exposures of dosimeters.
    h. Intentional deceptive exposures of dosimeters are forbidden and may result in enforcement actions.
6. Lost or damaged dosimeters shall be reported to the EHSD as soon as possible.
7. Persons who have lost or damaged their dosimeters shall be required to provide documentation of work activities and radioactive material uses as necessary for the EHSD to assess doses.
8. Where to Wear Dosimeters
    a. whole body dosimeters shall be worn at the location on the whole body likely to receive the highest dose (refer to definition of "whole body" in glossary)
    b. for persons performing diagnostic x-ray and/or fluoroscopy procedures, the dosimeter should normally be worn at the collar
    c. **for fetal monitoring for declared pregnant females**, whole body dosimeters should be worn on the abdomen. If a leaded apron is worn (as

in veterinary radiology), the dosimeter should normally be placed on the abdomen, under the apron.

d. if a leaded apron is worn, workers should wear whole body dosimeters outside of any leaded apron

e. TAMU normally uses ring dosimeters for extremity monitoring. Ring dosimeters should be worn on the hand most likely to receive the higher exposure, with the sensitive portion of the dosimeter turned toward the source of radiation (normally the dosimeter is worn with the name on the palm side of the hand)

f. ring dosimeters should be worn beneath protective gloves to reduce the likelihood of contaminating ring dosimeters

9. Permittees or their designees shall collect and return used dosimeters to the EHSD promptly after receiving replacement dosimeters at the beginning of a new wear period.

10. Any person who works with any source of radiation at TAMUS (or did so in the past) may request a copy of their dose records at any time. These records are maintained by and are available from the EHSD upon written request.

11. After termination of employment, a dose report (termination report) shall be provided to all persons who received doses exceeding 10% of any radiation dose limit in the applicable reporting period.

12. The EHSD shall recover costs for dosimetry services by charge-back to users. Contact the EHSD for additional information.

B. Internal Radiation Dosimetry

1. Intakes of radioactive materials and the resulting radiation doses shall be monitored by the EHSD to determine compliance with applicable regulations for

a. adults likely to receive, in one year, an intake in excess of 10% of the Annual Limit on Intake (ALI, 25 TAC §289.202(ggg)(2)); and

b. minors and declared pregnant women likely to receive, in one year, a committed effective dose equivalent (CEDE) in excess of 0.05 rem (50 mrem).

c. based upon a. and b. above and regulatory guidance from the U.S. Nuclear Regulatory Commission, cumulative (annual) activity use levels have been calculated for any given laboratory above which internal dose monitoring is required. These levels are presented in Table VI-1.

2. Internal dose monitoring may be accomplished by any of the following methods
   a. bioassay - direct measurement of radioactive material in the body (*in vivo* bioassay) or in bodily excretions (*in vitro* bioassay)
   b. airborne radioactive surveys combined (as necessary) with time and motion data.
   c. calculations based upon estimates of airborne concentrations and time and motion studies. This approach is only to be used in the absence of data necessary to support methods in a. and b. above.
   d. any combination of a, b, and c above.
3. Internal dose assessment shall be performed by the EHSD.
4. Permittees shall ensure that personnel using radioactive materials in excess of the activity levels in Table VI-1 contact the EHSD to arrange for bioassay procedures.
5. Bioassays are normally performed (or bioassay samples should normally be collected) 24-72 hours after potential exposure.
6. Measurements or calculations which confirm intakes and/or doses in excess of 2% of the annual dose limit shall be remeasured or recalculated as deemed appropriate by the EHSD.

Table VI-1 Activity Levels Above Which Internal Dose Monitoring is Required.

Radio-nuclide	Type of Confinement	Activity Handled in Unsealed Form: Volatile or Dispersible	Activity Handled in Unsealed Form: Bound to Non-Volatile Agent
I-125 or I-131	Glovebox	2,000 mCi/y	20,000 mCi/y
	Hood	200 mCi/y	2,000 mCi/y
	Open bench, normal ventilation	20 mCi/y	200 mCi/y
	Special operations, ventilation unknown	2 mCi/y	20 mCi/y
H-3	Glovebox	4,000 Ci/y	40,000 Ci/y
	Hood	400 Ci/y	4,000 Ci/y
	Open bench, normal ventilation	40 Ci/y	400 Ci/y
	Special operations, ventilation unknown	4 Ci/y	40 Ci/y
****	Glovebox	> 10 Ci/y	> 10 Ci/y
	Hood	> 10 Ci/y	> 10 Ci/y
	Open bench, normal ventilation	> 10 Ci/y	> 10 Ci/y
	Special operations, ventilation unknown	> 10 Ci/y	> 10 Ci/y

**** C-14, S-35 P-32, P-33, Ca-45, Tc-99m, Cu-64, Cr-51, Cs-137, Co-60
Contact the EHSD for radionuclides not on this list.

For minors or declared pregnant women, divide the activity levels above by 10.

C. Summation of Internal and External Doses

1. The EHSD shall sum internal and external doses to determine the Total Effective Dose Equivalent (TEDE) and/or the Total Organ Dose Equivalent (TODE) received by any exposed individual for whom monitoring is required pursuant to both A.1 and B.1 above.
2. The EHSD shall sum internal and external doses to determine the Total Effective Dose Equivalent (TEDE) and the Total Organ Dose Equivalent (TODE) received by the exposed individual for whom monitoring is not required pursuant to A.1 and B.1 above, but for whom doses were measured or estimated and shown to exceed 10% of the applicable annual dose limit.
3. Dose-related data is maintained on file at the EHSD. That data is available to Permittees and the exposed individual upon written request.

SECTION 7

RADIATION SURVEYS, POSTINGS, AND INSTRUMENTATION

Radiation surveys are used to identify and quantify radiological hazards and to document regulatory compliance. The EHSD and the Permittee must work together to ensure safety in the workplace and to protect both the public and the environment from the harmful effects of radiation.

A. Types of Surveys

1. Radiation surveys - may be performed to measure exposure or dose rates from sources of radiation which are in storage, in waste, or in use. Radiation surveys
   a. are required to be performed in laboratories using 10 millicuries or more of photon or neutron emitting radionuclides or radioactive sources.
   b. are required to be performed in laboratories using one or more of the radionuclides shown in step a. above when
      i. new and significantly higher activity sources are received,
      ii. radioactive material storage areas are relocated,
      iii. radioactive waste containers are relocated, and/or
      iv. radioactivity levels in storage are changed significantly.
   c. shall be performed and documented in accordance with the Radionuclide Laboratory Procedure Manual.
2. Contamination surveys - used to determine levels of radioactive contamination on surfaces in the laboratory or on personnel. Contamination surveys may involve the use of a portable instrument or the use of wipes which can subsequently be counted using a suitable radiation detector.
   a. Surveys shall be performed on a monthly frequency necessary to demonstrate compliance with the regulations. Regulatory guidance recommends
   b. Documented post-op surveys, those performed immediately upon completing an operation using radioactive materials, are of vital importance in identifying contamination and preventing its spread.

c. Contamination surveys shall be performed and documented in accordance with the Radionuclide Laboratory Procedure Manual.

3. Airborne radioactivity surveys shall be performed by the EHSD on an "as needed" or "on-request" basis.

4. Fume hood surveys are required annually or after maintenance which could affect fume hood face velocity. Fume hood surveys are performed by the EHSD.

B. Limits

1. Radiation levels

a. < 2 mrem in any one hour in unrestricted areas

b. < 50 mrem in any one year in unrestricted areas (< 5.7 μrem/hr) Exceptions may be granted by the EHSD.

c. in restricted areas, exposure rates should be kept ALARA (As Low As is Reasonably Achievable). Refer to Section 5, Control and Limitation of Radiation Exposures.

2. Contamination levels on laboratory surfaces (removable) as determined by either wipe survey or instrument survey:

a. no detectable contamination above background, i.e., not more than twice background levels

b. the determination of "no detectable contamination above background" must be made with a detector which has been response checked within the past 12 months and which is suitable for measuring the type(s) of radiation expected

c. if detectable contamination (greater than twice background) remains after decontamination efforts, contact the EHSD for assistance

3. Contamination levels on personnel or clothing - no detectable contamination above background. Contaminated areas are those areas where contamination levels exceed the values in the "Removable" column of 25 TAC §289.202(ggg)(6).

C. Postings

1. **Caution (or Danger) Radiation Area** - any 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 centimeters from the source of radiation or from any surface that the radiation penetrates.

2. **Caution (or Danger) High Radiation Area** - any 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 centimeters from the source of radiation or from any surface that the radiation penetrates.
3. **Caution (or Danger) Airborne Radioactivity Area** - any room, enclosure, or area in which airborne radioactive materials exist in concentrations in excess of levels specified in the regulations.
4. **Caution (or Danger) Radioactive Material(s)** - all doors or entrances to rooms or areas in which licensed radioactive materials are used or stored (EHSD may grant exceptions to this requirement as is consistent with state and federal regulations).
5. Signs and postings listed in 1 through 4 above should be removed when conditions no longer warrant that posting.
6. Signs and postings listed in 1 through 4 above shall conform to regulatory specifications on wording, symbol, and colors.

D. Labeling

1. **Caution (or Danger) Radioactive Material** labels shall be placed on radioactive materials containers holding radioactive materials in quantities (activities) greater than those specified in 25 TAC §289.202(ggg)(3) unless
   a. the containers are attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the applicable dose limits (refer to Section 5), or
   b. containers that are in transport and properly labeled for such.
2. **Caution (or Danger) Radioactive Material** labels should be placed on containers holding radioactive materials in quantities (activities) greater than 0.1 times the values specified in 25 TAC §289.202(ggg)(3) except as exempted in D.1.a and b above.

E. Requirements on Maintaining Radiation Detection Instrumentation

1. Each Permittee must possess radiation detection equipment that is appropriate for detecting the types of radiations emitted by the radionuclides for which the Permittee is authorized.
    a. for authorization to possess any quantity of H-3 (tritium) or quantities of C-14 of 250 μCi or less, Permittees must possess or have access to a liquid scintillation counter. Portable radiation detectors are not useable for detection of H-3 unless specifically designed as a tritium contamination detector;
    b. for authorization to possess any other beta emitting radionuclide, for C-14 in quantities exceeding 250 μCi, and for any gamma emitting radionuclide, the Permittee must possess a properly operating portable radiation detector appropriate for detecting those radiations;
        i. a thin window Geiger-Mueller (GM) detector is normally the best choice for most alpha and beta emitting radionuclides;
        ii. a portable scintillation detector (e.g. NaI or plastic) is required for Permittees authorized to possess I-125 in activities greater than 1 mCi.
    c. EXEMPTIONS - radiation detectors are not required for those Permittees who possess only
        i. Ni-63 sources in electron capture detector (ECD) cells used in gas chromatography
        ii. uranium or thorium in compounds in total quantities of 3 kilograms (6.6 pounds) or less
        iii. exceptions may be granted by the EHSD on a case-by-case basis.
2. Portable radiation detectors shall be calibrated or response checked, as appropriate for the use of the instrument, at least annually or after repair of the instrument. Battery replacement is not cause for performing a calibration. The EHSD will perform such calibrations and response checks at the request of the Permittee.
3. Prior to purchasing a portable instrument, Permittees are invited to contact the EHSD for recommendations on instruments and vendors.

SECTION 8
RADIOACTIVE MATERIAL SECURITY

Permittees are responsible for securing radioactive materials from unauthorized removal or access at all times in accordance with 25 TAC §289.202(y). In an academic environment, meeting this requirement can be difficult. Following are generally acceptable practices. If other security measures are employed, Permittees should consult with the EHSD.

A. If radioactive materials are accessible (unsecured) in a laboratory and no one is present in the laboratory, lock the laboratory doors to prevent unauthorized access; or

B. During periods when the laboratory is not locked, security may be maintained by direct surveillance. The person watching the lab or area shall be instructed to question unauthorized and/or unrecognized persons who enter the laboratory; or

C. If the Permittee chooses not to lock the laboratory doors or cannot be assured of adequate security when the laboratory is locked, the Permittee shall ensure that all radioactive materials are locked in a cabinet, drawer, refrigerator, freezer, etc. during periods when there is no direct surveillance by trained personnel.

D. It is acknowledged that the laboratory may be unoccupied for brief periods of time during which an individual may answer the telephone, get a drink, etc. These absences are allowed under the following instances:

1. experiments-in-progress wherein the total activity is less than 2 millicuries; or
2. radioactive waste containers in which the total activity present in that individual waste container is less than 5 millicuries; or
3. foil or sealed sources which are installed in a fixed/non-portable instrument or device, e.g., Ni-63 sources in ECD cells installed in a gas chromatograph.

E. Security of radioactive materials used in field experiments shall be reviewed by the EHSD on a case-by-case basis.

SECTION 9

TRAINING

All individuals who work with or near licensed or registered sources of radiation are required to complete radiation safety training. The depth of the training must be commensurate with the level of hazard to which the individual is exposed. **All training must be documented.** No individual shall be allowed to work unsupervised with licensed or registered sources of radiation until that person completes appropriate radiation safety training.

A. Basic Radiation Safety Training

1. All individuals, including principal investigators, who work with or are authorized to possess licensed or registered sources of radiation are required to satisfactorily complete appropriate radiation safety training course(s) offered by the EHSD and/or demonstrate competence on that subject matter by scoring at least 70% on a test administered or approved by the EHSD. The following standard courses are offered:
    a. General Radiation Safety Training for Open Isotope Users - a broad-based training course for users of unsealed radioactive material
    b. Sealed Source User Safety Training - a specific training course focusing on special needs of sealed source users
    c. Radioactive Material Transportation Training - training for persons who ship, receive, or transport radioactive materials.
2. Each Permittee is responsible for providing and documenting laboratory-specific training to individuals (including students) who work with licensed or registered sources of radiation under the Permittee's control. This training shall address, as applicable,
    a. Area restrictions - where radioactive materials are to be used within the lab(s) and restrictions on that use
    b. Location and procedures for radioactive material storage and security
    c. Posting locations for required signs and notices
    d. Walk-through review of protocols involving radiation sources

e. Special handling techniques which will minimize exposures when handling radionuclides

f. Availability of protective equipment and clothing

g. Radioactive material accountability

3. Radiation safety training shall be provided to persons who frequent areas where radioactive materials are used or stored, but who do not work with those materials. Examples include custodians, clerical personnel, etc. Except for the custodial staff, this training shall be the responsibility of the Permittee. Custodial staff shall receive radiation safety training through their administrative department (Physical Plant). Such training shall include

   a. a brief discussion of hazards of radiation and radioactive materials

   b. recognition of warning signs

   c. areas from which such persons are restricted

   d. person(s) to contact in the event of incident or emergency

4. EHSD provided refresher training shall be conducted at least once each two years for all individuals, including Permittees, who work with licensed sources of radiation, who are authorized to possess same, or who are listed as "authorized users" on a permit.

5. All training shall be documented and maintained on file by the Permittee. Training documentation shall include

   a. course title

   b. content of the training (outline, course description, etc.)

   c. instructor name

   d. date of training

   e. printed name of trainee(s)

   f. signature or initials of trainee(s)

   g. Department Name

   h. Permit Holder Name

6. Copies of individual employee training records from EHSD training courses are available from the EHSD.

SECTION 10

TRANSPORTATION OF RADIOACTIVE MATERIAL

Radioactive materials shall packaged and transported in accordance with all applicable rules and regulations specified by the U.S. Department of Transportation (DOT), the U.S. Nuclear Regulatory Commission (NRC), the Texas Department of State Health Services (DSHS), and International Civil Aviation Organization (ICAO) Technical Instructions. Texas A&M University's program is described in "Texas A&M University Hazardous Materials Transportation Program".

For the purposes of this manual, "transport" shall refer to the movement of radioactive materials in any vehicle on public roadways (including campus streets) or by air, water, or rail. Radioactive material which is hand carried or transferred on a moveable cart between laboratories or buildings on the same campus is not considered "in-transport".

A. Training Requirements

1. Any person who packages, transports, or receives radioactive material shipments and any person who prepares hazardous material transport documents or signs for the same, shall be trained and certified to do so by the TAMU EHSD, the Texas Engineering Extension Service, or other approved training organization.
2. Training shall be commensurate with the job duties of the individual.

B. Persons who are not properly trained and certified shall contact the EHSD for assistance in packaging, labeling and/or transporting radioactive materials.

C. At no time shall any Permittee or any person acting on behalf of a Permittee carry radioactive material aboard a passenger-carrying aircraft. Contact the EHSD for more information and possible exceptions.

D. Transport of moisture gauges or density gauges shall be performed in accordance with procedures prepared by the TAMU EHSD. Anyone wishing to transport gauges must be:
1. a trained radiation worker under the permit the material is authorized under and,
2. certified in hazardous materials transport by TAMU.
Contact EHSD for more information.

SECTION 11

INSPECTIONS OF PERMITTEE OPERATIONS

Permittees may be inspected at any time by either the TAMU EHSD or the Texas Department of State Health Services (DSHS). The following information is intended to make the Permittee aware of the inspection program and to provide general information on what is expected of the Permittee.

A. Inspections by the Texas Department of State Health Services (DSHS)

1. Annual inspections of the EHSD by the Texas Department of State Health Services may include spot inspections of individual Permittees. Such inspections are typically unannounced.
2. Inspections of Permittees not located on the TAMU main campus may be expected at least once each two years. Surprise (unannounced) inspections may be performed at any time. Inspections are typically unannounced. Permittees are required to notify EHSD as soon as the inspection is scheduled and, in any case, when the inspector arrives and departs.
3. Permittees not located on the TAMU main campus must provide office or desk space for the inspector and facilitate the inspections by fulfilling all reasonable requests of the inspector.
4. Permittees not located on the TAMU main campus should request that the inspector to hold an exit interview at which time the inspector should discuss any apparent deficiencies or violations found. The Permittee should further request that EHSD be allowed to participate (e.g., by telephone) in the exit interview.
5. Permittees should keep in mind that the EHSD may have duplicates of any records found to be missing. By calling the EHSD during the inspection and having those duplicates faxed, the Permittee may avoid being cited for violations.

B. Inspections by the Environmental Health and Safety Department

1. EHSD inspections of Permittees on the TAMU main campus are of two types
   a. Monthly inspection - typically involves
      i. performance of a contamination survey

ii. survey instrument check

iii. check on postings in laboratory

iv. ensuring that RAM use areas and waste containers are marked

v. RAM is appropriately secured in laboratory or personnel challenge entry by visitors

b. Radiation Safety Laboratory Review - These reviews are conducted at least once every 2 years for each lab, with the emphasis being on risk. Laboratories that order/use higher activities, exhibit problems during the Monthly inspection, fail to return required reports, or for other reasons will receive more frequent inspections. The review consists of items covered during the Monthly inspection and:

i. review of training records

ii. review of worker list

iii. review of procedures

iv. review of Permit authorizations and conditions

v. performance of radiation area surveys in restricted and unrestricted areas, as appropriate for the radionuclides and activities present

vi. review of Permittee inventory

vii. review of radioactive material security

viii. review of Permittee's survey records

2. EHSD inspection of Permittees not located on the TAMU main campus shall be conducted at least once each two years. In addition to all of the items inspected during the biennial inspection (above), remote site inspections will also involve

a. review of sealed source leak tests, if applicable

b. verification of availability of regulations and license

c. review of receipt, transfer and disposal records

d. review of transportation records

e. review of logs of moisture gauge use (check-out and return) records

3 EHSD reserves the right to inspect any Permittee with no advance notice. However, all routine inspections shall be announced and scheduled at a time that is mutually acceptable with the Permittee.

4. Inspection reports shall be generated by the EHSD and a copy sent to the Permittee.
5. Permittee responses, if any, shall be filed with the EHSD inspection report and maintained on-file at the EHSD.

SECTION 12

INCIDENTS AND EMERGENCIES

In the event of a radiological incident or emergency, the TAMU EHSD must be notified immediately. In instances where there is doubt about whether such notification is necessary, contact should be made to allow the EHSD staff member on duty to assess the situation and initiate the appropriate response.

The staff of the EHSD is "on-call" for emergency response 24-hours per day, seven days per week. Any individual may contact the EHSD to obtain assistance. Emergency telephone numbers shall be posted in every laboratory in which radionuclides are used.

During normal business hours:

(979) 845-1361 (EHSD Main Office)

After normal business hours, weekends and holidays:

(979) 862-1111 (Health Physicist on Duty)

(979) 845-4311 (University Communications Office)

or

(979) 845-2345 (University Police Dispatcher)

A. What Constitutes an Incident or Emergency

1. Loss or theft of any radioactive material or radiation producing device.
2. High or potentially high radiation exposure to an individual or to a member of the public. For example
   a. greater than 500 mrem in one month or less to any occupationally exposed individual
   b. greater than 5000 mrem in one month or less to the extremity of any occupationally exposed individual
   c. greater than 10 mrem to any member of the public
3. Intake or potential intake of radioactive materials by inhalation, ingestion, absorption through skin, or injection through skin or wound
4. Deceptive or potentially deceptive exposure of a dosimeter

5. Personnel contamination that cannot be completely removed after two washes with only soap and water.
6. Spills involving any quantity of alpha emitting radionuclide, more than 1 microcurie of iodine-125 or iodine-131, or spills involving more than 10 microcuries of any other radionuclide.
7. Any spill which is not or cannot be completely decontaminated before the end of that work day.
8. Identification of any contamination which is outside of the restricted area, such as spills tracked or otherwise spread into offices, hallways, vehicles, etc.
9. Accidental releases of radioactive material to the environment.
10. Fires or floods which threaten to release radioactive materials to the environment or which threaten to expose emergency response personnel.
11. Any transportation accident, whether on-campus or off-campus, involving radioactive materials.
12. Any personnel injuries which may involve radioactive contamination or radiation exposure.

B. Personnel Injury Involving Actual or Suspected Contamination or Exposure to Radiation

1. Provide first aid immediately for serious injuries.
2. Call 9-911 from a University telephone.
3. Notify the EHSD.
4. As possible, without doing harm to the victim, monitor the injured individual and remove contaminated clothing and gross personal contamination.
5. Provide a detailed written report to EHSD within 5 working days.

C. Decontamination of Personnel

1. Remove and bag all contaminated clothing.
2. Skin contamination should be cleaned using mild soap and tepid water. Use portable survey meter to monitor for remaining contamination. If not free of contamination, rewash and resurvey. Decontamination solutions which are formulated for use on skin may be used, if available.
3. Call the EHSD to report the incident even if the decontamination was successful.

4. Survey for contamination elsewhere on body as well as on clothes, shoes, floor, door handles, telephone, etc. Document the surveys.
6. If the contamination is in a wound (e.g., a cut from contaminated glassware) rinse the wound with copious quantities of water.
7. Write an account of the incident, signed by the author and the Permittee, and send a copy to the EHSD.

D. Radioactive Spills or Releases

Decontamination shall be the responsibility of the group that caused the spill. For large spills (i.e., greater than 10 microcuries) or spills that are difficult to clean up, the work should be carried out under the supervision of the EHSD. Appropriate protective clothing shall be worn during decontamination activities. Steps to respond to spill incidents are:

1. Stop work and confine the spill immediately using an absorbent, enclosure, etc. Call EHSD immediately.
2. Warn others of the hazard and isolate the area.
3. Monitor personnel during and after cleanup for contamination.
4. Collect all used cleanup materials as radioactive waste. Remove and bag all contaminated clothing or cleanable items for removal by the EHSD.
5. Commence wipe surveys and decontamination. Ensure surveys of surrounding areas are performed to ensure that all contaminated areas are identified.
6. Prepare a written report on the incident. Send one copy to the EHSD.

SECTION 13

FIELD STUDIES WITHIN TEXAS, NATIONAL AND INTERNATIONAL STUDIES, AND EXPERIMENTS INVOLVING RELEASE OF RADIOACTIVE MATERIALS TO THE ENVIRONMENT

A. Field Studies are loosely defined as those experiments conducted outside of a TAMUS laboratory, whether or not the experiment is intended to release radioactive materials to the environment. Routine administration of radionuclides to animals at the College of Veterinary Medicine are generally not considered to be field studies. Individual field studies shall be specifically approved by the Radiological Safety Committee or a Subcommittee appointed by the Chairperson.

1. Examples of field studies include
    a. Experiments conducted on plants located in a multi-user greenhouse or in the field, whether or not the field is TAMUS property,
    b. Radioactive material administered to animals which are not housed in buildings on the TAMU campus nor in facilities which are located on authorized remote sites on the TAMU license - such as cattle, deer, or sheep confined in outdoor pens or corrals or animals located at zoos, animal parks, etc., and
    c. Radioactive material used in the environment including those used at sea, on lakes or ponds, in rivers, underground, in aircraft, etc.
2. The following are **excluded** from the definition of field studies
    a. radioactive material use in approved mobile radionuclide laboratories such as the radionuclide van used aboard TAMU research vessel R/V Gyre or the radionuclide van and permanent laboratories aboard the International Ocean Drilling Program (IODP) vessel, currently the JOIDES Resolution.
    b. use of portable moisture/density gauges within the state of Texas

3. Permittees shall submit to the EHSD an application at least 60 days prior to the anticipated start of the field experiment. Applications shall contain the following information, as appropriate
    a. a detailed description of the experiment to be performed including radiological information, location, date(s), personnel involved (TAMUS and non-TAMUS), etc.
    b. an assessment of accidental release probability and consequences
    c. a statement regarding the degree of control which can and will be maintained over the experimental area - specifically, how will the Permittee maintain control of the radioactive material?
    d. written approval from the appropriate authority (TAMUS or non-TAMUS) for conducting experiments using radioactive materials.
    e. plans for transport and disposition of radioactive materials and any waste generated.
    f. other information requested by the EHSD or Radiological Safety Committee
4. Experiments in which radioactive materials are expected to be released directly to the environment shall also include information as required in Part C below.

B. National and International Studies - Texas A&M University has been issued a license by the U.S. Nuclear Regulatory Commission which authorizes limited uses of radionuclides at sea (outside of state territorial waters).

1. Permittees intending to use radioactive materials outside of Texas shall submit the following information to the EHSD for approval at least 180 days in advance of the start of the experiment. This requirement only applies to persons wishing to use the radioactive material under a TAMU license.
    a. radionuclide, quantity/activity, and chemical form to be used
    b. description of experiment including expected radioactive waste volume
    c. detailed description of location of use
    d. documented approval of local (at the proposed experiment location) authority for use of radioactive materials

e. plans for transportation of radioactive materials and waste

f. plans for maintaining control over radioactive materials during and after field use

g. list of personnel (and documentation of personnel training) involved

h. the anticipated schedule

2. All users of radioactive materials outside of Texas which are performed under a TAMU license shall comply with TAMU policies and procedures except as otherwise authorized by the TAMU EHSD.

C. Experiments Involving Expected Release of Radioactive Materials into the Environment under DSHS L00448

1. Permittees must receive approval from the EHSD for any experiment in which radioactive materials are expected to be released to the environment. This includes but is not limited to

a. greenhouse experiments wherein $^{14}CO_2$ or other radioactive compound is expected to be released to air or water, and

b. animal studies, other than those associated with veterinary medical diagnosis and therapy, wherein radioactive materials will be released to an unrestricted area via excreta.

2. Applications for approval must be submitted to the EHSD at least 90 days prior to the intended start of the experiment. Applications shall include the following information, as appropriate

a. location and description of experiment

b. a description of the distribution of the human population and livestock population in and near the experimental area. As a minimum, distances to the nearest residence, food crop, beef cattle herd and dairy herd are required.

c. height of release (top of fume hood stack above ground, height of release point, etc.)

d. outside building dimensions (height, width, length)

e. radionuclide and activity to be released

f. statement explaining why the release cannot be avoided or reduced

g. topographical map of the location of the experiment including area watersheds, domestic water supplies, crops, etc.

SECTION 14

PERMITTEE RECORDS

Record keeping requirements vary depending upon whether the Permittee conducts licensed activities on the TAMU campus or elsewhere. For those on campus, many records are maintained at the EHSD thereby relieving the Permittee of some responsibilities. For those not on campus, additional records must be available for inspection by the Texas Bureau of Radiation Control and, therefore, more records must be kept on file by the Permittee.

A. General Record-Keeping Requirements

1. All Permittees on the TAMU campus in College Station shall maintain the following records in a clear, concise and orderly format. Retention periods are included in parentheses.
    a. permit records (life of permit)
        i. approved application for permit with original RSC signatures
        ii. all amendments, requests for amendment, and Permit renewals
    b. transfer and disposal records for every licensed source of radiation (1 year after final disposal)
    c. copies of inventory reports (1 year)
    d. surveys (1 year)
        i. contamination surveys
        ii. radiation field surveys in restricted areas
        iii. radiation field surveys in unrestricted areas
    e. survey instrument calibrations performed by anyone other than the EHSD (3 years)
    f. personnel records (1 year)
        i. worker/user lists
        ii. training records
    g. operating and emergency procedures (current)
    h. procedure manuals from EHSD (current)
    i. records of radiation safety training performed by the Permittee (3 years)

2. In addition to maintaining duplicates of all records in step 1 (except 1.d, 1.g, and 1.i above), the EHSD shall maintain the following records which are available for review during normal office hours.
   a. original copy of all radioactive material licenses issued to TAMU
   b. copies of current state and federal regulations relating to radioactive materials
   c. official inventory records
   d. inspection reports and copies of all "Notices of Violation" issued by state or federal regulatory agencies and the TAMU responses to those Notices.
   e. current version of all policy manuals and procedure manuals
   f. calculations and reports as required for compliance with the Clean Air Act for radionuclide releases from TAMUS facilities
   g. dosimetry records
   h. leak test results
   i. survey instrument calibrations

B. Additional Record-Keeping Requirements for Permittees Not on the TAMU Campus

1. All Permittees not located on the TAMU campus in College Station shall maintain the documentation identified in A.1 above and shall also maintain the following records. Retention periods are included in parentheses. There is one exception to the record retention requirements from A.1. Receipt, transfer and disposal records for every licensed source of radiation at remote sites must be maintained **for the life of the permit**.
   a. Current copy of (or electronic access to) current DSHS rules, e.g. 25 TAC §289.202 (until superseded)
   b. Current copy of (or electronic access to) the TAMU license, L00448 (until superseded)
   c. Records of most recent inspection performed by the Texas Department of State Health Services (DSHS) including (3 years)
      i. any "Notice of Violations" issued
      ii. TAMU response to those violations
   d. Sealed Source Leak Test Reports (5 years)
   e. Survey Instrument Calibrations (3 years)

f. Radiation Protection Plan review (current)

g. Sealed source use log (3 years)

C. Information Required on Specific Records

1. Radioactive material receipt surveys, radiation surveys, & contamination surveys

   a. records shall be in units of dpm, becquerels (Bq), μCi, mR/h, mrem/h, etc., as appropriate. Units of "cpm" or "counts" are not acceptable for quantitative surveys records.

   b. records shall uniquely identify the source of the radiation

   c. records shall clearly indicate the areas surveyed (include a map)

   d. records shall indicate the person performing the survey and date of survey

   e. records shall uniquely identify the survey instrument used, i.e., serial number, or other unique description

2. Training records are specified in Section 9.

SECTION 15
SPECIAL REQUIREMENTS FOR USERS OF SEALED SOURCES

Sealed sources are those which are permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions that are likely to be encountered in normal use and handling. Within TAMUS, the most common uses of sealed sources are in moisture gauges and electron capture detector (ECD) cells.

Some sealed sources may be capable of generating significant radiation fields when in use or when removed from storage. However, sealed sources should never leak radioactive materials if used in accordance with the manufacturer's guidance. For this reason, radioactive contamination is highly unlikely. Sealed source leak tests are used to confirm and document the integrity of the source encapsulation and the absence of contamination.

A. Special Requirements: Sealed sources

Permitted Users authorized to possess sealed sources are required to

1. Perform sealed source leak tests when and as prescribed by EHSD procedures as scheduled by EHSD.
2. Moisture/density gauges users shall create and maintain a use-log which identifies where adevice is at any time (when it is not in storage) as well as identifying the person responsible for maintaining control of the gauge while it is in use.
3. Define a storage area which has adequate security.
4. Conduct or arrange for the TAMU EHSD to conduct storage area surveys
    a. on initially establishing the storage location,
    b. when changing a storage location,
    c. when adding a gauge to a storage location, or
    d. when the occupancy of the areas adjacent to the storage location are changed.
5. Ensure that only persons who have been properly trained may have access to or operate a moisture/density gauge or other device containing a sealed source.

6. Ensure that the moisture/density gauges and other source(s) are transported in accordance with U.S. Department of Transportation regulations and procedures provided by the TAMU EHSD.

SECTION 16

GLOSSARY OF TERMS

"Absorbed dose" means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy). 1 Gy = 100 rad.

"Activity" means the rate of disintegration or transformation or decay of radioactive material. The units of activity are "disintegrations per second (or minute)" (dps or dpm), curie (Ci) and the becquerel (Bq). 1 Ci = 37,000,000,000 dps (3.7×10^{10} dps)
1 Ci = 2,220,000,000,000 dpm (2.22×10^{12} dpm)
1 Bq = 1 dps

"Adult" means an individual 18 or more years of age.

"Agreement State" means a state which has executed an agreement with the U.S. Nuclear Regulatory Commission transferring to the state the responsibility for regulating uses of certain radioactive materials within its borders. Texas is an agreement state.

"Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, particles, mists, vapors, or gases.

"Airborne radioactivity area" means a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

(1) in excess of the derived air concentrations (DACs) specified in 25 TAC 289.202 Appendix B, Table I, Column 1; or

(2) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

"Annual Limit on Intake (ALI)" means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

"As low as is reasonably achievable (ALARA)" means making every reasonable effort to maintain exposures to radiation as far below regulatory dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of ionizing radiation and licensed sources of radiation in the public interest.

"Background radiation" means radiation from cosmic sources; non-technologically enhanced naturally occurring radioactive material, including radon, except as a decay product of source or special nuclear material, and including global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include sources of radiation from radioactive materials regulated by the Texas Bureau of Radiation Control (BRC).

"Becquerel (Bq)" means the System International (SI) unit of activity. One becquerel is equal to 1 disintegration or transformation per second (dps).

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

"Byproduct material" means:

(1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material; and

(2) the tailings or wastes produced by or resulting from the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes, and other tailings (or wastes) having similar radiological characteristics.

"CFR" means Code of Federal Regulations.

"Committed dose equivalent ($H_{T,50}$ or CDE)" means 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.

"Committed effective dose equivalent ($H_{E,50}$ or CEDE)" means 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 each of these organs or tissues ($H_{E,50} = \Sigma\, W_T, H_{T,50}$).

"Curie (Ci)" means a unit of measurement of activity. One curie (Ci) is that quantity of radioactive material that decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used sub-multiples of the curie are the millicurie and the microcurie. One millicurie (mCi) = 1×10^{-3} curie = 3.7×10^{7} dps. One microcurie (μCi.) = 1×10^{-6} curie = 3.7×10^{4} dps. One nanocurie (nCi) = 1×10^{-9} curie = 3.7×10^{1} dps. One picocurie (pCi) = 1×10^{-12} curie = 3.7×10^{-2} dps.

"Declared Pregnant Woman" means a woman who voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

"Deep dose equivalent (H_d or DDE)," which applies to external whole body exposure, means the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm^2).

"Depleted uranium" means the source material uranium in which the isotope uranium -235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

"Derived Air Concentration (DAC)" means the concentration of a given radionuclide in air which, if breathed by Reference Man (1.2 cubic meters of air per hour) for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

"Dose" is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent.

"Dose equivalent (H_T)" means 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 sievert (Sv) and rem. 1 Sv = 100 rem.

"Dose limits" means the permissible upper bounds of radiation doses established in accordance with these rules. For purposes of the rules, "limits" is an equivalent term.

"Dosimeter" means devices designed to be worn by a single individual for the assessment of dose equivalent. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

"Effective dose equivalent (H_E)" means the sum of the products of the dose equivalent to each organ or tissue (H_T) and the weighting factor (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma\, w_T H_T$).

"Embryo/fetus" means the developing human organism from conception until the time of birth.

"Entrance or access point" means any opening through which an individual or extremity of an individual could gain access to radiation areas or to licensed or registered sources of radiation. This includes portals of sufficient size to permit human access, irrespective of their intended use.

"Exposure" means the quotient of dQ by dm where "dQ" is the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass "dm" are completely stopped in air. The unit of exposure is the coulomb per kilogram (C/kg) or the roentgen (R). 1 R = 2.58 x 10^{-4} C/kg.

"Exposure rate" means the exposure per unit of time, typically milliroentgen per hour (mR/h).

"External dose" means that portion of the dose equivalent received from any source of radiation outside the body.

"Extremity" means hand, elbow, arm below the elbow, foot, knee, and leg below the knee. The arm above the elbow and the leg above the knee are considered part of the whole body.

"Eye dose equivalent (LDE)" means the external dose equivalent to the lens of the eye at a tissue depth of 0.3 centimeter (300 mg/cm^2).

"Gray (Gy)" means the System International (SI) unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

"High radiation area" means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 millisievert) in 1 hour at 30 centimeters from any source of radiation or from any surface that the radiation penetrates.

"Human use" means the internal or external administration of radiation or radioactive material to human beings for healing arts purposes or research and/or development. Human use is specifically prohibited under all licenses issued to Texas A&M University.

"Internal dose" means that portion of the dose equivalent received from radioactive material taken into the body.

"Ionizing radiation" means any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. Ionizing radiation includes gamma rays and x rays, alpha and beta particles, high speed electrons, neutrons, and other nuclear particles.

"License" means a form of permission given by the Texas Department of Health, Bureau of Radiation Control, or the U.S. Nuclear Regulatory Commission to an applicant (in our case, Texas A&M University) who has met the requirements for licensing set out by that Agency (Texas BRC or U.S. NRC)

"Licensed material" means radioactive material received, possessed, used, or transferred under a license issued by the Texas Bureau of Radiation Control or the U.S. Nuclear Regulatory Commission.

"Licensee" means any person or organization who is licensed by the Texas Bureau of Radiation Control or the U.S. Nuclear Regulatory Commission. Texas A&M University is the licensee.

"Lost or missing source of radiation" means a source of radiation whose location is unknown. This definition includes licensed material that has been shipped but has not reached its planned destination and whose location cannot be readily traced in the transportation system.

"Member of the public" means any individual, except an individual who is performing assigned duties for a licensee or registrant involving exposure to sources of radiation.

"Minor" means an individual less than 18 years of age.

"Natural radioactivity" means radioactivity of naturally occurring nuclides whose location and chemical and physical form have not been altered by man.

"Occupational dose" means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to sources of radiation. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

"Permit" means a form of permission given by the TAMU Radiological Safety Committee to an applicant (faculty or staff of Texas A&M University) to possess, store, and/or use radioactive material or radiation producing devices under the authority granted to Texas A&M University in the applicable License. A Permit is issued to one individual; never to a department, office or group of individuals.

"Permittee" means the successful applicant, the individual named on the Permit. "Permittee" is synonymous with "Permitted User" or "Sub-licensee".

"Quality factor (Q)" means the modifying factor that is used to derive dose equivalent from absorbed dose.

Radiation	Quality Factor
beta	1
gamma	1
x-ray	1
alpha	20
neutron	varies from 3 - 10

"Rad" means the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 gray).

"Radiation" means one or more of the following:

(1) gamma and x rays; alpha and beta particles and other atomic or nuclear particles or rays;

(2) stimulated emission of radiation from any electronic device to such energy density levels as to reasonably cause bodily harm; or

(3) sonic, ultrasonic, or infrasonic waves from any electronic device or resulting from the operation of an electronic circuit in an electronic device in the energy range to reasonably cause detectable bodily harm.

"Radiation area" means any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

"Radiation machine" means any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation.

"Radiation safety officer" means an individual who has a knowledge of, and the authority and responsibility to apply appropriate radiation protection rules standards, and practices, and who must be specifically authorized on a certificate of registration or radioactive material license.

"Radioactive material" means any material (solid, liquid, or gas) that emits ionizing radiation spontaneously.

"Radioactivity" means the disintegration of unstable atomic nuclei with the emission of radiation.

"Radiobioassay" (See "Bioassay").

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

"Restricted area" means an area, access to which is limited by the licensee or registrant for the purpose of protecting individuals against undue risks from exposure to sources of radiation. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

"Roentgen (R)" means the special unit of exposure. One roentgen (R) equals 2.58×10^{-4} coulombs/kilogram of air. (See "Exposure").

"Sealed source" means 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 that are likely to be encountered in normal use and handling.

"Shallow dose equivalent (H_S or SDE)," which applies to the external exposure of the skin or an extremity, means the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.

"Sievert" means the System International (SI) unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

"Source material" means:

(1) uranium or thorium, or any combination thereof, in any physical or chemical form;

or

(2) ores that contain by weight 0.05 percent or more of:
(i) uranium,

(ii) thorium, or
(iii) any combination thereof.

"Source material" does not include special nuclear material.

"Special nuclear material" means:
(1) plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, but does not include source material; or
(2) any material artificially enriched by any of the foregoing, but does not include source material.

"Survey" means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, and/or presence of sources of radiation. When appropriate, such evaluation includes, but is not limited to, tests, physical examination of location of materials and equipment, and measurements of levels of radiation or concentration of radioactive material present.

"Total effective dose equivalent (TEDE)" means the sum of the deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.
TEDE = DDE + CEDE

"Total organ dose equivalent (TODE)" means the sum of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest dose.
TODE = DDE + CDE

"Unrestricted area" means an area, access to which is neither limited nor controlled by the licensee (or Permittee).

"Whole body" means for purposes of external exposure, head, trunk(including male gonads), arms above the elbow, or legs above the knees.

"Worker" means an individual engaged in work under a license or a Permit.