RADIATION SAFETY MANUAL

POLICIES AND PROCEDURES

FOR

RADIATION PROTECTION

AT

TEXAS TECH UNIVERSITY

LUBBOCK, TEXAS

Modified

December 1, 1999

SECTION I – MANAGEMENT OF BROAD LICENSE
TABLE OF CONTENTS

SECTION I – MANAGEMENT OF BROAD LICENSE

SECTION II – SUB-LICENSE PROGRAM SAFETY

SECTION III – RADIATION PRODUCING MACHINE SAFETY PROGRAM

SECTION IV – LASER SAFETY PROGRAM

SECTION V EMERGENCY PROCEDURES

SECTION VI – RADIATION SURVEYS

SECTION VII – FORMS AND RECORDS

APPENDICES - RADIATION SAFETY INFORMATION AND RESOURCES

Introduction

The purpose of this manual is to provide users and non-users of radioactive material, and radiation producing equipment the more significant facts and figures about radiation. Overviews of state regulations, and direct Policies and Procedures concerning different areas of radiation use at Texas Tech University are covered. The Regulations, Policies and Procedures, etc. set forth in this guide have one single straight forward purpose, to protect Texas Tech University faculty, staff, students, and visitors against unnecessary and potentially harmful radiation exposure.

A. Definitions of Key Terms and Acronyms

1. **Agency** means the Bureau of Radiation Control, Texas Department of Health.
2. **ALARA**: means "as low as reasonably achievable".
3. **BRC** means the Bureau of Radiation Control, Texas Department of Health.
4. **License**: means Texas Radioactive Material License No. **L01536**, issued by the Agency.
5. **Registration** means Texas Registration of Radiation Producing Machines No. **R00574**.
6. **RSC** means the Radiation Safety Committee of Texas Tech University.
7. **RSM** means TTU's Radiation Safety Manual.
8. **RSO**: means the Radiation Safety Officer
9. **RSS**: means the Radiation Safety Specialist.
10. **RST** means the Radiation Safety Technician
11. **TAC:** means the **Texas Administrative Code**.
12. **TRCR**: means the **Texas Regulations for Control of Radiation**.
13. **US NRC:** means the United States Nuclear Regulatory Commission.
14. **US DOT**: means the United States Department of Transportation

B. Radiation Protection Program

1. **Objective:** This program is designed to limit occupational and public doses of radiation to "as low as reasonably achievable" to protect the staff, employees, and students of Texas Tech University (TTU); to protect members of the general public; and to comply with **25 TAC §289.202(e)** [Texas Regulations for Control of Radiation (TRCR) 21.101].

2. **Method:** Texas Tech University (TTU) has established this **Radiation Safety Manual (RSM)** to provide safety guidance to its staff and students when working with radioactive material, x-ray producing devices, and lasers.

3. **Date of Implementation:** December 1, 1999, upon approval by the **RSC**.

4. **Review:** This program will be reviewed no later than the anniversary month of its inception, each year.

5. Program Elements:

a. Personnel Monitoring Requirements and Dose Limits: Specific procedures are provided in II.G. of the **RSM**. Specific ALARA procedures are addressed in II.B.19 of the **RSM**. Both areas have steps listed in various general procedures. If this program is adhered to, the limits specified in **25 TAC §289.202(f)** through **§289.202(o)** [TRCR 21.201 through 21.302] should not be exceeded.

b. Radiation surveys: Radiation surveys are discussed in II.H.6. of the **RSM**.

c. Access Controls for Radiation Areas: Access to the radiation areas is controlled by II.J. of the RSM. In addition, certain elements of storage, use, and maintenance/service procedures contain steps which specifically address access controls.

d. Respiratory Protection: Addressed in II.J. of the **RSM**.

e. Security of Radiation Sources (Storage/Use): Specific procedures for storage security are addressed in II.H.1. of the **RSM** and provides for security during certain activities (storage, use, and transport) as procedural steps.

f. Posting of Areas and Rooms: II.H.1. of the **RSM** provides for posting of warning signs.

g. Labeling of Containers: II.H.1. of the **RSM** provides procedures for labeling of containers.

h. Receipt of Packages Containing Radioactive Material: Radioactive material receipt procedures are specified in II.H.3.b. of the **RSM**.

i. Waste Storage, Processing, Transfer and/or Disposal Procedures: Transfer/waste procedures are specifically addressed in II.H.14 of the **RSM** and transport procedures are addressed in II.H.4.

j. Management of Required Records: Records management procedures are addressed in II.H.2. of the **RSM**.

k. Reports of Incidents: The RSO is responsible for reporting incidents. The specific procedures are found in Section V of the **RSM**.

C. ALARA Program - General

1. **Maximum permissible dose:** A sub-licensee (TTU) may not permit an individual in a restricted area to receive a total effective dose equivalent greater than that permitted under II.G. of the **RSM**. There should not be any situations at TTU where dose equivalents for external and internal exposures exceed those listed in II.G. of the **RSM**.

2. **Individual's Dose Assessment:** Before any initiating work in a restricted area, the **RSO** shall make a determination of the total effective dose equivalent for each individual, in accordance with **TAC §289.202(j)**.

3. **Prohibition:** No sub-licensee or employee shall possess, receive, use, or transfer radioactive material in such a manner as to cause an individual in a restricted area to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in **Table II** of subsection **TAC §289.202(ggg)(2)**.

4. **Prohibition of Use by a Minor:** There shall be no use of radioactive material or radiation producing equipment by employees under 18 years of age (minors), pregnant females, or females suspecting pregnancy at Texas Tech University. However, exceptions may be granted by the **RSC**, following the requirements of **TAC §289.202**.

D. Radiation Safety Management – the TTU radiation safety program is controlled by the **RSC** and radiation safety is monitored by TTU's **Radiation Safety Office** which is directed by the **RSO**. Should an operation be presenting a threat to the staff or students of TTU, or to any member of the general public, the **RSO** has the authority to cause any radiation user of radiation sources to cease and desist from operations until such time as the radiation threat is removed or mitigated.

E. Radiation Safety Committee:

1. **Purpose and Structure:** The **RSC** is composed of a group of administration, faculty, and staff appointed by the Executive Vice President and Provost to establish policies and regulations governing the use of ionizing and non-ionizing radiation. The president has designated the Office of the Associate Vice President for Operations as his duly authorized representative on matters relating to Radiation Safety.

2. **Duties (RSC Charge) -** The **RSC** will:
   - **a.** establish policies and procedures, as well as provide administrative advice regarding radiation and laser safety;
   - **b.** approve or disapprove all applications, amendments, and renewals relating to the use of radioactive materials, lasers, or radiation producing equipment;
   - **c.** receive and review reports from the RSO on monitoring, surveillance, and personnel exposure;
   - **d.** monitor procurement, use, and disposal procedures;
   - **e.** take appropriate corrective action on radiation/laser incidents, including administrative guidance and license suspension or revocation;
   - **f.** provide a representative to the University Safety and Health Committee; and
   - **g.** serve as an avenue of appeal in cases of dispute and exception to actions by the RSO.

3. **Radiation Safety Committee Membership –** The committee shall be composed of:
   - **a.** Three faculty members who regularly uses radioactive materials;
   - **b.** Two faculty members who regularly uses lasers;
   - **c.** At least one faculty member who regularly uses radiation producing equipment;
   - **d.** At least two faculty/staff members who are non-users of radioactive materials, lasers, or radiation producing equipment;
   - **e.** Vice Provost for Research or designated representative;
   - **f.** RSO (Ex-Officio); and
   - **g.** Associate Vice President for Operations, (Ex-Officio)

4. **Radiation Safety Committee Appointment -** The members of the committee will be appointed by the Executive Vice President and Provost. Members of the committee, other than those specified by virtue of their position, will be nominated by the committee chairperson and the Associate Vice President for Operations. The **RSO** will serve as Executive Secretary to the committee. Each member will serve a term of three years except when lesser terms may be required to maintain balanced membership and continuity of committee operations. Reappointments are permissible.

5. **Radiation Safety Committee Operating Procedures:**
   - **a.** The RSC shall schedule a regular meeting for each month of the year. Additional meetings may be called as necessary. The RSO will prepare and distribute a written agenda to committee members at least one day before each scheduled meeting.
   - **b.** A quorum, at least one-half of the voting members, is required to conduct official business. The RSO, Chairperson, and Vice Provost for Research (or designated representative) must be present to constitute a quorum.
   - **c.** Sub or ad hoc committees may be appointed by the Chairperson as needed.
   - **d.** If a committee member is unable to continue serving on the committee for any reason, the member shall notify the Chairperson so that a replacement may be appointed promptly.
   - **e.** If a committee member fails to attend three consecutive meetings or one-half of the called meetings in a twelve month period, without just cause, the Chairperson will contact that member to determine if that person should be replaced. If so, the Chairperson will ask the Associate Vice President for Operations to arrange for a replacement under the appointment procedures of the committee.

6. **Radiation Safety Committee Responsibilities -** The **RSC** shall:
   - **a.** Establish policies regarding radiation and laser safety;
   - **b.** Provide administrative advice to the RSO on matters regarding radiation and laser safety;
   - **c.** Receive, review, and act on all applications for the use of radiation sources in any areas used by TTU personnel;
   - **d.** Receive and review periodic reports from the RSO on monitoring, contamination, and personnel exposure;
   - **e.** Periodically review the overall use of radiation and laser sources at TTU from the standpoint of operational hazards;
   - **f.** Receive and review all reports from the RSO concerning radiation and laser incidents at TTU;
   - **g.** Conduct necessary investigations, hearings, and/or appropriate corrective action on any radiation or laser over-exposure or spill occurrence at TTU;
   - **h.** Meet at least monthly during the academic year.
   - **i.** Perform an annual audit of the Radiation Safety Program.
   - **j.** Upon committee action, issue sublicenses which will be duly signed and approved by the Chairperson of the RSC.

F. Radiation Safety Officer

1. **Responsibilities –** the Radiation Safety Officer (**RSO**) will be a trained health physicist who is responsible for TTU-wide compliance with these policies and the regulations. The RSO will also provide a variety of technical services necessary to maintaining radiation safety and compliance with regulatory requirements.

2. **RSO Duties -** The duties of the **RSO** include:
   - **a.** Overseeing all operating, safety, emergency, as low as reasonably achievable (ALARA) procedures, and health physics procedures and activities, including both personnel and environmental monitoring, and reviews them annually;

b. Furnishing consulting services to personnel at all levels of responsibility on all aspects of radiation protection, including instruction of radiation safety classes;
c. ensuring that required radiation surveys and leak tests are performed and documented in accordance with TAC §289.252 and the Radiation Safety Manual, including any corrective measures when levels of radiation exceed established limits;
d. Receiving, delivering, and shipping all radioactive materials coming to or leaving TTU property;
e. Monitoring all accelerators and other machines capable of producing penetrating radiation;
f. Distributing and processing personnel monitoring equipment including maintaining records of internal and external personnel exposure, notifying individuals and their supervisors of exposures approaching the maximum permissible limits, and recommending appropriate remedial action;
g. Investigating the circumstances and causing a report to be submitted to the agency for each known or suspected case of radiation exposure to an individual or radiation level detected in excess of limits established by TAC §289.252 and each theft or loss of source(s) of radiation, to determining the cause(s), and to taking steps to prevent recurrence;
h. Investigating the circumstances and causing a report to be submitted to the agency for each known or suspected case of release of radioactive material(s) to the environment in excess of limits established by TAC §289.252;
i. Instructing personnel in proper procedures for the use of radioactive materials;
j. Supervising and coordinating the waste disposal program, including keeping of waste storage and disposal records;
k. Storing of all licensed radioactive materials not on sub-licenses;
l. Ensuring the proper storing, labeling, transport, and use of sources of radiation, storage, and/or transport containers;
m. Performing and/or supervising all in-house sealed source leak tests;
n. Maintaining an inventory of all radioactive materials, radiation producing equipment, and lasers on TTU property;
o. Supervising decontamination of radioactive material accidents;
p. Maintaining a continuous program of environmental radiation hazard evaluation through routine lab inspections and hazard elimination;
q. Maintaining radiation safety program records in the Radiation Safety Office;
r. Reporting regularly to the RSC;
s. Maintaining a thorough knowledge of management policies and administrative procedures of TTU;
t. Prohibiting and preventing, by immediate suspension or termination if necessary, any unsafe or illegal use of radioactive material, radiation producing equipment, or lasers.
u. Maintaining files on each sub-licensee in the Radiation Safety Office, and providing each sub-licensee with a copy (and updates) of the "Radiation Safety Manual - Texas Tech University Policies and Procedures for Radiation Safety"; and
v. Performing other tasks requested by the RSC.

G. Radiation Safety Office – conducts operations and services to support TTU's radiation safety program.

1. The **Radiation Safety Office** will be under the supervision of the **RSO** and will be staffed with at least one trained and qualified radiation safety technician, one trained and qualified radiation/laser safety specialist, and with part/full time clerical staff as necessary to fulfill the duties and obligations of the radiation safety program.
2. The **Radiation Safety Technician** will support the **RSO** and the **RSC** by performing assigned routine safety functions which include, but are not limited to:
   - **a.** Performing and documenting radiation surveys of radiation levels in TTU facilities;
   - **b.** Performing and documenting radiation surveys of contaminated, or potentially contaminated, surfaces and areas in TTU facilities;
   - **c.** Placing, or verifying the correct placement of, required warning labels and signs on containers, room entrances, and areas according to the requirements of this manual;
   - **d.** Controlling movement and storage of packages and containers of radioactive materials and wastes;
   - **e.** Performing and documenting leak tests of sealed sources;
   - **f.** Inspecting radiation survey instruments to assure current calibration;
   - **g.** Testing fume hoods to assure proper operation;
   - **h.** Performing calibration of radiation survey instruments according to the procedures listed in Appendix C of this manual; and
   - **i.** Other duties as assigned by the **RSO** or **RSC** or directed by the TTU Administration.

3. The **Radiation/Laser Safety Specialist** will support the **RSO** and the **RSC** by performing assigned routine safety functions which include, but are not limited to:
   - **a.** Processing and approving orders of radioactive materials;
   - **b.** Receiving and delivering all incoming radioactive materials;
   - **c.** Maintaining the inventory of all radioactive materials;
   - **d.** Performing inspections, surveys, and audits;
   - **e.** Ordering, delivering, and retrieving dosimetry badges and maintaining the dosimetry program;
   - **f.** Assisting with the radioactive waste program;
   - **g.** Maintaining records for the above functions; and
   - **h.** Other duties as assigned by the RSO or RSC or directed by the TTU Administration.

4. Radiation Safety staff will coordinate with the sub-licensee prior to entering any area under the sub-licensee's supervision or control.

H. Personnel Monitoring Procedures

Introduction - This section will give direct information regarding the initiation, requirements, use, and termination of the personnel monitoring service for radiation exposure at Texas Tech University.

1. **Requirements** - The regulations require that personnel monitoring devices (i.e. film badges) be provided and records be kept for an individual who receives, or is likely to receive, a dose in any calendar year in excess of 10% of the values discussed in II.G.

Exemptions may only be granted by the Bureau of Radiation Control (BRC) of the Texas Department of Health (TDH).

2. **Method** - The radiation reaching the badges, being worn for monitoring, exposes the badge or chip. Special filters in the badge holder allow distinguish between varying degrees of radiation penetration, thus indicating the exposure received by the person wearing the badge. The only purpose of the badge is to record the exposure of an individual. The badge does not protect an individual from radiation.

3. **Monitoring periods:** vary according to badge type and use. Each individual should check to see the length of the monitoring period they will be following. A general rule to follow will be: film badge - monthly, TLD badge - quarterly. **ANY** individual not returning a badge of any type will be subject to a dose assessment in accordance with **TAC §289.202** and **BRC** Regulatory Guide 5.7. The dose assessed could result in the maximum permissible exposure for that time period, possibly resulting in the loss of the right to work with radioactive material and/or radiation producing equipment.

4. **Personnel Monitoring Procedures:**

   a. Requests for Dosimetry:

   (1) **ALL** personnel working with radioactive material or radiation producing equipment will be required to file a "Request for Dosimetry Service". The **RSO** will make a determination from the information given on the "Request" as to the type of monitoring needed for that particular individual. Personnel exempted from badge-type dosimetry will be those who work only with pure alpha emitters, or beta emitters having a maximum energy of less than 0.2 MeV, in which case an internal dosimetry program is required if the committed effective dose equivalent exceeds 10 percent of annual limits of intake (ALI) as listed in **Columns 1 and 2** of **Table I** of **TAC §289.202(ggg)(2)**. The **RSO** will determine who will be issued badge-type dosimetry.

   (2) Any person filing a "Request for Dosimetry" that has worked with radioactive material, radiation producing equipment, or has been previously monitored for radiation exposure at a pervious institution(s) will be asked to fill out the information needed on the "Request for Dosimetry" form and the "Previous Exposure History Request".

   (3) After receiving the "Request" the RSO will order the dosimetry (if needed). No use of radioactive material or radiation producing equipment will be allowed until confirmation from RSO or dosimetry has been received.

   b. Termination of Service: The following rules should be followed for dosimetry service termination:

   (1) Individual user should give a minimum 30 day notice of his/her intent to be deleted from the service. This should be done in advance of a new monitoring period, therefore allowing enough time to ensure that deletion will be completed without a new badge being issued.

(2) Individual user will return badge to sub-licensee or RSO upon completion of work with ionizing radiation or before leaving Texas Tech.
(3) All individuals are urged to request their permanent exposure history from TTU. The Radiation Safety Office will forward permanent exposure histories in accordance with TAC §289.202. Please allow enough time for final badge to be developed, interpreted, and results sent to Texas Tech.

c. Procedures for Wearing of Badges: Rules regarding the wearing and use of personnel monitoring devices:

(1) Attach the badge holder to the area of your garment most likely to be exposed to the radiation.
(2) When not in use, leave the badge in a radiation free area. DO NOT take the badge home, leave it in your car, or other areas subject to exposing the badge to significant changes in heat, humidity, or light, unless on official business for TTU involving ionizing radiation.
(3) NEVER wear another person's badge.
(4) Report the loss of a badge or holder to the RSO immediately.
(5) NEVER put a badge in a situation where it could become contaminated by radioactive material or exposed to unnecessary radiation. Specifically, never wear ring badges on the outside of gloves, never leave badges lying near radioactive material or radiation producing equipment, even for short periods of time.
(6) THE BADGE ISSUED TO YOU IS YOUR RESPONSIBILITY.
(7) Take care not to send your badge to the laundry with your lab coat.
(8) NEVER puncture, remove, or alter in anyway the badge holder or its contents.
(9) REMEMBER - A rule cannot be written to cover every possible situation, use COMMON SENSE when no rule is available
(10) Reports of exposure to ionizing radiation are kept by the Radiation Safety Office. Any individual may request (in writing) top review his/her exposure reports at any time. However, the request should indicate the report(s) needed for review.

I. Bioassay Procedures

1. Requirement: Staff and students must submit to the appropriate bioassay procedure if indicated by any of the conditions described below. It is conceivable, although not likely, that a person not involved in any operation using radioactive materials might be exposed. In that event, those individuals must also have the appropriate bioassays performed.

2. Urinalyses:

a. Any person who uses 8 mCi (millicuries) or more of hydrogen-3 (tritium) in any single operation or within a one (1) week period will submit to a urinalysis. Urine samples will be taken before work begins and weekly during use. Results will be provided to the person, regardless of outcome.

b. Any person who uses 20 mCi (millicuries) or more of carbon-14 in any single operation will submit to a urinalysis. Urine samples will be taken before work begins and weekly during use. Results will be provided to the user, regardless of outcome.

3. **Thyroid counts -** Thyroid scans will be conducted on any individual that handles, in open form, volatile Iodine-125 in amounts greater than:

   a. **0.1 mCi** -- when the procedure or set of procedures is performed in an open area and NOT within a fume hood;

      and/or

   b. **1.0 mCi** -- when the procedure or set of procedures IS performed within a fume hood.

   Note 1: the **RSO must be contacted** if amounts **greater than 10 mCi of Iodine-125** are to be handled.

   Note 2: All procedures involving greater than 1.0 mCi of volatile Iodine-125 will be performed within a fume hood. Refer to PPRP Section VI (A.7,A.11,J.6). Thyroid scans will be performed prior to handling volatile Iodine-125 in the amounts indicated above and between 6 hours and 72 hours after the procedure or set of procedures. Contact the **RSO** to set up the thyroid scans.

   Note 3: Reference "Regulatory Guide 8.2 - Applications of Bioassay for I-125 and I-131", U.S. Nuclear Regulatory Commission or applicable guides approved by the Bureau of Radiation Control.

4. **Additional Requirements:**

   a. **Periodic bioassays** may be necessary for any individual who is suspected of having ingested, inhaled, or absorbed any radioactive material. The type of bioassay will be determined by the **RSC** upon consultation with appropriate regulatory agencies or health physics consultants, if necessary.

   b. In Vitro bioassays, other than urinalysis, will be performed when determined by the **RSC**, after consultation with appropriate regulatory agencies or health physics consultants.

5. **Records:** all results of bioassays will be recorded and filed in the individual's personnel monitoring file.

END OF SECTION

SECTION II – SUB-LICENSE PROGRAM SAFETY

Introduction - This section will detail the procedures and requirements for obtaining a sub-license for radioactive material, radiation producing equipment, and lasers. Also included will be procedures for renewals and amendments.

A. Definitions:

1. **Broad License –** the specific radioactive materials license issued to TTU by the Bureau of Radiation Control of the Texas Department of Health. This license authorizes all radioactive materials use programs to be conducted at the discretion of the **RSC**.

2. **Sub-license –** an authorization issued by the **RSC** to use radiation sources.

3. **Sub-licensees -** Authorized users, usually faculty members, whose training and experience are such that they have been sub-licensed by the **RSC** to use ionizing and/or non-ionizing radiation in their research and educational activities.

B. Sub-License Application Procedures

1. **Qualifications for Sub-License**
   - **a.** The applicant must have sufficient training and experience in the use of the radioactive material, radiation producing equipment, or laser(s) requested to ensure that proposed work is conducted and/or supervised in a safe manner.
   - **b.** The applicant must submit an application for the particular sub-license needed, and a resume of use and experience within the area of interest shown by the application. This resume may include papers written referencing the use of that particular material or instrument, and/or any formal training courses or continued education.
   - **c.** The applicant must specify on the application the types and amounts of radioactive materials or radiation producing machines to be licensed as well as the procedures involved.
   - **d.** The **RSC** will authorize issuance of the sub-license if it determines that all requirements have been met.
   - **e.** The **RSC** may require an applicant to attend the TTU Radiation Safety Shortcourse and/or obtain experience by working under an active sub-license for a specified period.
   - **f. Requirements for Individuals Working Under an Applicant's Sub-license:**
     (1). Workers (technicians, students, graduate assistants, post doctorals, etc.) must attend the local Radiation Safety Shortcourse.
     (2). The shortcourse will be four hours for workers who can prove by appropriate certificate that prior radiation safety training was completed within the last five years.
     (3). The shortcourse will be eight hours for workers who have finished at least two years of college but have not had prior training within the last five years.

(4). For workers who have not had prior training and have completed less than two years of college education, 24 hours of training will be required.

2. Procedures for Obtaining a Sub-license

a. The **RSO** will first review all applications.

b. If an application **(for amendment or renewal only)** is properly completed by the applicant or authorized user and a qualifying inspection (for new laboratories) or a recent inspection of the laboratory by the TTU Radiation Safety Office shows that the laboratory is in compliance with state and local regulations, interim approval not to exceed 30 days may be granted by the **RSO**.

c. Final approval of all applications is required by the TTU **RSC** at its regular monthly meeting.

d. To be considered for final approval **all** applications including amendment and renewals must be submitted at least two working days before the next regularly scheduled meeting.

e. All applications must be filled out completely and signed by the applicant. All applications not filled out completely and correctly will be returned to the applicant for re-submission.

3. Sub-license Renewal and/or Amendment

a. Term of Sub-license - Texas Tech University sub-licenses remain in effect for two years from date of issue.

b. Renewal - Although the Radiation Safety Office will generally remind sub-licensees of a pending expiration, it is the sole responsibility of the sub-licensee to submit the renewal application timely to avoid expiration of a sub-license before receipt of renewal application by the Radiation Safety Office.

c. Actions or activities requiring an amendment to a sub-license:

(1) If there is a change in the terms and conditions of sub-license or if procedures authorized by it change] (personnel, lab relocation, etc.);
(2) If an increase in maximum allowable activity is expected or needed;
(3) If a different isotope is needed;
(4) If isotope(s) on sub-license are no longer needed;
(5) If there is a change in equipment (X-ray or Laser inventory);
(6) If there is a significant change in submitted Operating Procedures.
(7) If significant changes occur in the normal operation of sub-license procedures, for example, the use of animals, increased waste disposal, etc.
(8) Application forms for license renewal or amendment are available from the Radiation Safety Office or may be found in this manual.

C. Absence Of Sub-Licensee From Campus - a sub-licensee who expects to be absent from the campus for a time period of greater than three weeks must:

1. Suspend or terminate the use of radionuclides or radiation producing equipment.

2. Notify the **RSO** as to the responsible individual (another sub-licensee) who will take over supervision of the use of the various radionuclides or radiation producing equipment to be used. This sub-licensee must be competent in the use and regulations concerning the radionuclides to be used or the radiation producing equipment to be used.

3. Should arrangements for either 1 or 2, above, NOT be made, the **RSC**, with may 1) suspend the sub-license or 2) revoke the sub-license, and 3) name a responsible sub-license to act for the absent sub-licensee.

4. A sub-licensee leaving the campus for a visiting professorship at another institution:

- **a.** May transfer the radioactive material to that institution pending notification of approval by the Radiation Safety Offices of both institutions;
- **b.** Transfer the radioactive material to another TTU sub-licensee pending approval of the **RSO**;
- **c.** Placed the radioactive material in storage with the **RSO**; or
- **d.** Dispose of the radioactive material.

D. Procedure for Termination of a Sub-license - The following procedure shall be used should a sub-licensee desire to terminate his/her radioactive material or radiation producing equipment sub-license.

1. A letter of intent to terminate the sub-license will be submitted to the **RSO**. This letter will include:

- **a.** The date of termination.
- **b.** The listing of the sub-licensee's authorized laboratories, including storage and waste areas. A diagram of all these areas should accompany this letter of intent.
- **c.** A statement that all radioactive materials, and radioactive wastes used and/or stored will be removed. They must be transferred either to the **RSO** for storage or disposal, or properly transferred to another sub-licensee who is properly authorized to possess the materials and activities under consideration, without exceeding his/her limits, or makes application to amend the radionuclides and activities to his/her sub-license. NOTE - This would also apply to radiation producing equipment.
- **d.** The terminating sub-licensee will provide copies of the results of an IN DEPTH contamination survey on the laboratories, equipment, storage and waste areas authorized on his/her sub-license. If contamination levels greater than those listed in **TAC §289.202(ggg)(6)** are found, the contaminated areas and/or equipment will be decontaminated until allowable limits are reached.
- **e.** Upon receipt of the letter of intent, the **RSO** will conduct a close-out survey of the affected areas and equipment.
- **f.** Based on a review of the letter of intent, the results of the close-out survey, and the disposition of the radioactive material or radiation producing equipment, the **RSO** will

make his recommendations to the **RSC** at its next monthly meeting, which in turn will consider and vote on the request to terminate the sub-license.

g. Upon termination, all signs and labels, indicating that the areas were authorized for use of radioactive material, shall be removed by radiation safety personnel. The areas are now considered for unrestricted use. Areas with radiation producing equipment may or may not qualify for unrestricted use.

h. ON TERMINATION, FURTHER USE OF RADIOACTIVE MATERIAL BY THE SUB-LICENSEE AND INDIVIDUAL WORKERS OF THAT SUB-LICENSE IS STRICTLY PROHIBITED.

i. All equipment and personnel monitoring devices (i.e. survey meters, shielding, film badges, etc.) not owned by the terminating sub-licensee must be returned to the radiation safety office or to owners of the equipment at this time.

j. Should a sub-licensee permanently leave TTU and neglect to officially terminate his/her sub-license, the **RSO** upon notification will contact the absent sub-licensee's Department Chairperson. The Department Chairperson will be responsible for initiating the sub-license termination procedures as outlined above.

E. Sub-licensee Inspection/Monitoring Program- The following procedures outline the TTU inspection/monitoring program conducted for evaluation of programs operated under sub-licenses.

1. General - A radiation program the size of TTU requires periodic monitoring, inspection, and evaluation. It is the responsibility of each sub-licensee to ensure his/her monitoring is complied with by performing required radiation surveys. It is the responsibility of the **RSO** to make periodic inspections and surveys of each sub-licensee to ensure he/she is in compliance with all state and local regulations.

a. The entire program at TTU is periodically evaluated by the TTU-**RSC** and by the Texas BRC for compliance.

b. This system of "checks and balances" assures TTU and the general public that the radiation program at TTU operates safely and efficiently.

2. Frequency of Inspections -

a. The **RSO** shall make inspections of radioactive material sub-licensees on a quarterly basis.

b. The **RSO** shall make inspections of radiation producing equipment sub-licensees on an annual basis.

c. Sub-licensees who have had their area deactivated do not have to be inspected.

3. Inspection Policy/Responsibilities

a. The **RSO** shall inspect facilities for compliance with all applicable regulations - state, federal, and local.

b. The **RSO** shall make a record of each inspection and keep those on file in the Radiation Safety office.

c. The **RSO** will forward a formal report of inspection (Form RS-24) to each sub-licensee within two weeks of final evaluation of his/her inspection results, noting corrective action needed.

d. Each sub-licensee will revise or correct his/her individual program as noted in the report under "Corrective Actions". Questions or problems should be addressed to the **RSO** or the **RSC**.

e. The **RSO** will report all major deficiencies as well as any instance of non-compliance for a sub-license, applicable rules, or statutes, to the **RSC**.

f. The **RSO** shall make follow-up inspections of all sub-licensees having deficiencies deemed serious by the **RSC** within 60 days of report.

g. All inspection statistics should be evaluated by the **RSC**.

h. Sub-licensees having repeated deficiencies (same deficiency during two consecutive inspections) will be reported to the **RSC** and the **RSC** will issue written notice.

i. Sub-licensees found to repeat a deficiency a third time (same deficiency during three consecutive inspections) will be reported to the **RSC**. The **RSC** will issue a written notice and require the sub-licensee to meet with the committee during next scheduled meeting to explain their actions.

j. The **RSC** may terminate a sub-license if serious deficiencies are continued.

F. Sub-License Programs and Procedures

1. Sub-Licensee/Authorized User Responsibilities

a. Each authorized user has the following obligations:

(1). Ensuring that the individual user responsibilities are discharged by those under their control and supervising their work;

(2). Working within the limits of the User's sub-license;

(3). Instructing those employees for whom they are responsible in the use of safe techniques and in the application of approved radiation safety practices and ensuring attendance in required radiation safety courses;

(4). Furnishing the **RSO** with information concerning individuals and activities in their areas;

(5). Ensuring that all surveys and safety checks required for their particular area of interest are carried out and recorded properly;

(6). Contacting the **RSO** whenever major changes are anticipated in operational procedures, new techniques, alterations in physical plant, or when new operations that might lead to personnel exposure;

(7). Complying with the regulations governing the use of radioactive materials, radiation producing equipment, or lasers, as established by the Texas Regulations for Control of Radiation, Texas Regulations for Control of Laser Radiation Hazards, and Texas Tech University Policies and Procedures for Radiation protection;

(8). Keeping stocks of stored radioactive material to a minimum;
(9). Complying with proper procedures for termination of equipment, or termination of sub-license involving the use of radioactive material, radiation producing equipment, or lasers;
(10). Complying with the proper procedures for handling radiation incidents;
(11). Obtaining prior approval, by completing and submitting an application for amendment/renewal form, for the addition/deletion of rooms, radioisotopes, or personnel, for the increase/decrease of radioactive material, or for additions or changes to procedures.

b. Responsibilities of Authorized Users - Authorized users (workers, employees, etc.) faculty, students, other professionals, as well as technical and other workers engaged in education, laboratory research, and research support activities which involve actual use and handling of materials and devices producing ionizing and non-ionizing radiation. These personnel will work under the immediate supervision of a sub-licensee.

G. Maximum Permissible Doses, Dose Limits

1. Like other materials with potential health hazards, regulatory control is applied to exposures involving radiation workers throughout the nuclear industry as well as medical and research facilities. Workers exposed to ionizing radiation as part of their normal duties assume an occupational risk and therefore are regulated under a "maximum permissible dose". The Texas Regulations for Control of Radiation and Title 10 Code of Federal Regulations Part 20 currently accepts the following as "maximum permissible dose":

2. No sub-licensee or employee shall possess, use, receive, or transfer sources of radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from all sources of radiation a total occupational dose in excess of the limits specified as follows:

a. The annual occupational dose shall not exceed the more limiting of:
(1) the total effective dose equivalent being equal to 5 rems (0.05 sievert); or
(2) the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 sievert).

b. The annual occupational dose to the lens of the eye, to the skin, and to extremities will not exceed:
(1) an eye dose equivalent of 15 rems (0.15 sievert), and
(2) a shallow dose equivalent of 50 rems (0.5 sievert) to the skin or to any extremity.

c. The annual occupational dose to minors will not exceed 10 percent of the limits specified in (a.) and (b.) above [reference **TAC §289.202(l)**].

d. The annual occupational dose to an embryo or fetus during the entire pregnancy of a declared pregnant woman will not exceed 0.5 rem (0.005 sievert). Refer to **TAC §289.202(m)**.

e. The total effective dose equivalent to individual members of the public will not exceed 0.1 rem (1.0 millisieverts) in a year, and that the dose rate in any unrestricted area from external sources will not exceed 0.002 rem (0.02 millisieverts) in any one hour.

H. Policies and Procedures for Radioactive Material Use – This section will give specific Policies and Procedures for the use of radioactive material. Pertinent facilities, record keeping, handling of radioactive material, radiation contamination surveys, custodial service for radioactive material areas, neutron meters, radioactive material in animals and radioactive waste.

1. Facilities

a. Work areas(s) (benches, hoods, trays, etc.) will have a non-absorbent surface.

b. Laboratories will have wall coverings of a washable, hard, heat-chemical resistant paint (i.e. epoxy).

c. Laboratories will have protective floor coverings and ventilation capable of handling and storing the isotopes and activities being requested. (reference CRC Handbook of Laboratory Safety, p. 437-439)

d. Storage areas, work areas, refrigerators, freezers, fume hoods, and lab entrances will be posted with the correct warning signs. (signs available from Radiation Safety)

e. Storage areas (cabinets, refrigerators, freezers, fume hoods, laboratories, etc.) will be secured to prevent unauthorized removal of radioactive material.

f. Storage containers will have radioactive material labels with date, type, and activity of isotope(s). This will apply to any container with radioactive material that will be in use more than one (1) working day.

g. Work area air levels shall be kept below 10% of those limits given in **TAC (§289.202(ggg)(2)**. If circumstances require concentrations in air to exceed 10% of the above, then the **RSO** will need to be notified.

h. All signage (sub-license, Notice to Employees, emergency numbers, etc.) shall be posted in prominent view.

i. Remote handling devices will be used when handling energetic beta or gamma sources. In general this refers to sources above approximately two-tenths of one MeV (0.2) that might be indirectly unshielded or potentially contaminated. If a person is unsure as to the proper action to take consult the **RSO**.

j. Each laboratory will have a [calibrated] survey meter capable of detecting radioactive material(s) used in that particular laboratory if the radioisotopes and activities of those isotopes are detectable with a meter. This survey meter is not to be used for actual contamination surveys, only for dose level surveys, spot contamination surveys, and personnel exit surveys.

k. NOTE - All costs for procurement, calibration (annually), and repair will be assumed by the sub-licensee. Survey meters are available (limited number) from Radiation Safety for short-term loan. Also the calibration of certain types of survey meters is available through the radiation safety office.

l. Work areas may need a fume hood in order to comply with regulatory limits. The following lists some minimal features the fume hoods should have:

NOTE - Fume hoods should be used anytime a person is handling unsealed, potentially volatile forms of radioactive material. Operations involving the use of more than 0.1 millicuries of Iodine-125 or Iodine-131 in volatile form shall be conducted within a properly operating fume hood.

(1) Fume hoods shall be labeled if radioactive materials are to be used or stored in the hoods.
(2) The velocity of the air flow shall be such that there can be no escape of air into the work place from the fume hood under normal conditions, including opening of doors and windows, suction of other fume hoods, and air conditioning systems. The velocity of the air flow shall be no less than 80 lfpm and no more than 120 lfpm.
(3) The gas, water, and electrical appliance should be operable from the outside of the fume hood.
(4) The fume hood shall have a counter-balanced sash made of tempered safety glass.
(5) The fume hood should have a layer of absorbent paper with water-proof backing covering the entire work surface.
(6) The inspections shall be conducted by the Department of Environmental Health and Safety.

2. Record Keeping

a. Wipe survey results - Survey records shall be continual, observing no stops in record keeping and according to **TAC** requirements. Surveys shall be in proportion to isotope use, hence the records shall be the same.

b. Isotope Use Forms - All isotope use forms (Form RS-14) shall be kept by the sub-licensee. The use forms shall be separated by those in use and those exhausted. The Radioisotope Use Form is a 3 part form used to indicate, and verify the sub-licensee's use and disposal of radioactive material. At such time when the radioactive material is no longer useful or is exhausted, the total amount used, disposed, or released to atmosphere must be written on the "use form".

c. Request for Radioactive Waste Disposal - All Requests for Radioactive Waste Disposal (Form RS-14A) shall be kept by the sub-licensee. Form RS-14A is a multi-part form used for waste identification, disposal information, and hazard identification. The form is used to comply with Texas Regulations for Control of Radiation, Dept. of Transportation Regulations, Code of Federal Regulations Part 49, Environmental

Protection Agency Regulations, Texas Water Commission, and Disposal Site Regulations.

d. Inventory - all sub-licensees will keep a copy of the most recent semi-annual radioactive material inventory.

e. Inspection Reports - All sub-licensees should keep their semi-annual inspection reports (Form RS-24).

f. Amendment/renewals - All sub-licensees should keep a copy of their amendments and renewals.

g. Organization - All survey records shall be kept in format so as not to confuse routine inspections or audits. Records shall be sectioned so as to separate use forms, inventories, survey records, etc. Use forms should be separated by isotope and kept in chronological order by date received.

h. Availability - Records shall be kept in an area of the laboratory free of contamination and shall be available during routine monitoring of the lab by Radiation Safety personnel and/or regulatory agencies.

3. Control of Radioactive Material

a. Ordering Radioactive Material – General Procedure

(1) Requestor calls the Radiation Safety Office

Phone: 742-3876

(2) The requestor shall have the following information for Radiation Safety:

(a) Sub-licensee
(b) Isotope
(c) Activity (in millicuries ONLY)
(d) Chemical form
(e) Requestors phone number
(f) Local point of contact
(g) Vendor
(h) Account Number
(i) Total dollar amount

(3) The **Radiation Safety Office** will;
(a) check the sub-licensee's current inventory to verify that the isotope and requested activity does not exceed the sub-licensee's limit.
(b) check the TTU Broad License to verify that the isotope and requested activity doe not exceed the TTU Broad License Limit.
(c) check the compliance, records, and violations of the sub-licensee.

NOTE - Should the purchase exceed either the sub-license or Broad License limits the **RSO** will call the requestor and ask him/her to amend the order to an acceptable limit or amend his/her current inventory by resubmitting of Radioactive Material Inventory.

(4) The **Radiation Safety Office** will call Purchasing and provide the needed information. The buyer will give the **Radiation Safety Office** the P.O. number.
(5) The buyer will then verify the account funds and call the requestor, giving him/her the P.O. number. Requestor calls the vendor providing the needed information.
(6) ALL radioactive material shipments must be shipped to the following address:

ATTN: Radiation Safety Officer
Administrative Support Center
2903 4th Street, Room 122
Texas Tech University
Lubbock, Texas 79409

(7) Requestor will then complete the regular purchase order form. The requestor shall type or write (legibly) the words "Radioactive Material" on the purchase order form.

b. Receipt and Accountability of Radioactive Material

(1) **Receipt**

(a) The receipt of all radioactive material shipments should be during normal business hours, unless special arrangements have been made with the Radiation Safety Office. When ordering radioactive material, the requestor should emphasize this to the vendor and make sure the vendor will ship accordingly.
(b) Upon receipt, the package(s) will be monitored in accordance with **TAC §289.202(ee)**.

(2) **Accountability**

(a) A "Radioactive Material Use Form" (Form RS-14) will be prepared and issued to sub-licensee upon his/her receiving the shipment.
(b) The "Radioactive Material Use Form" is a 3 part form used to document a sub-licensees use and disposal of that particular shipment. When the material is no longer useful or exhausted the sub-licensee will verify that all use and disposal (dry, liquid, atmosphere, etc.) has been recorded on the form. It shall be the responsibility of the sub-licensee to apply mathematical decay calculations in order to determine the amount used and/or disposed.

NOTE - Only sub-licensees or personnel named on the sub-license will be allowed to sign for and receive the shipment.

(c) Upon final use (described above) the sub-licensee shall verify the aforementioned, then date, sign and return the YELLOW copy to the Radiation Safety office.
(d) After receiving the yellow copy the Radiation Safety Office will audit the "use form" and if filled out correctly will delete the shipment from the sub-licensee's inventory and the TTU Broad License.

(3) **Semi-annual radioactive material inventories** are required of all sub-licensees. Sub-licensees will submit the inventory as requested by the **RSO**.

Remember - It is the responsibility of the sub-licensee to apply any mathematical decay calculations.

4. Transfer and Shipping of Radioactive Material

a. Transfer - There shall be no transfer of radioactive material from one sub-licensee to another sub-licensee, nor outside of TTU, without the approval of the **RSO**.

b. Shipping -

(1) If radioactive material is to be shipped from TTU, the shipper must notify the Radiation Safety Office.
(2) The **RSO** will then assist the shipper in preparing the package for shipment according to Department of Transportation Regulations, Texas Regulations for Control of Radiation, and Nuclear Regulatory Commission (NRC) Regulations.

NOTE - The recipient of any regulated radioactive material to be shipped from TTU must provide evidence of an NRC (or agreement state license) by furnishing a copy of his/her license to the Radiation Safety Office. This must be done prior to shipment.

5. Storage of Radioactive Material

a. Radioactive material shall be stored only in approved areas.
b. The storage container shall be of such construction to prevent unneeded external exposure to radiation present therein. Furthermore, the container shall be "double-contained" meaning the container shall be able to hold/or absorb twice the volume of the material therein.
c. Storage of radioactive material, animal containing radioactive material and parts thereof shall be such as to prevent unauthorized removal.

d. All refrigerators and freezers for storage of radioactive material shall be equipped with hasps and combination locks. A copy of the combination shall be forwarded to the Radiation Safety Office.

6. Radiation Surveys

a. Each sub-licensee shall perform or have performed by individuals listed on sub-license, laboratory surveys where radioactive material or radioactive waste is being used or stored.

b. These surveys shall be performed in direct proportion to isotope use. Surveys shall be **continual**, even during periods of inactivity.

(1) Using filter paper (Whatman 1-4.25cm or equivalent), wipe an area of 100 cm^2.

> **NOTE:** Using an "S" motion of about 12-16 inches will give approximately this area. Although there is no set minimum or maximum for the number of wipes for a laboratory, one should make sure the number of wipes taken show radioactive material use areas, radioactive material storage areas, rad-waste storage areas, and heavy traffic areas (door knobs, floors, phones, cabinets, etc.).

(2) Count the wipes with a radiation detection system capable of monitoring the desired radiation energy and type. NOTE - Survey meters are not capable of being used for quantitative analysis (i.e. counting purposes). They should only be used for routine surveys, personnel lab exit surveys, and contamination location.

(3) Results of the smear surveys should be corrected for efficiency and reported in units of activity (i.e., dpm, Bq, etc.).

(4) The following shall be maintained in the survey log book:
   (a) survey date and name of surveyor
   (b) counts per minute
   (c) results in units of activity
   (d) map of laboratory
   (e) swipe locations
   (f) efficiency of counter

(5) All results shall be recorded whether positive or negative.

(6) If results show removable contamination of more than 1000 dpm for beta emitters (Hydrogen-3, Carbon-14, Phosphorus-32, Phosphorus-33, Sulfur-35, Calcium-45, Zinc-65), or 200 dpm for Iodine-125, notify the Radiation Safety Office and begin decontamination procedures.

> **NOTE**: be sure to always do a background count with each survey and indicate on your machine copy results which sample is the background count

(7) Equipment in a radiation laboratory shall not be removed from that laboratory until demonstrated by the **RSO** to be free of radioactive contamination.

(8) Equipment to be repaired by persons outside the laboratory shall be demonstrated to be free of radioactive contamination by the **RSO**. Emergency equipment repair by outside personnel shall be supervised by the **RSO**. It is the responsibility of the laboratory personnel to request this supervision from the Radiation Safety Office.

(9) Routine surveys by the Radiation Safety Office in no way release a sub-licensee from his/her obligation to their surveys.

(10) In general, NO radioactive contamination can be tolerated. Exceptions to this will include certain hood trays, dry boxes, stainless steel trays, absorbent paper, or other equipment which is used frequently for active work and which will be clearly marked with standard radiation caution signs and stickers. However, these items shall be decontaminated or disposed of after experiment or use and before deactivation or termination of sub-license.

(11) Decontamination - ALL decontamination will be carried out by the sub-licensee responsible for the contamination under the supervision of the **RSO**. All costs for decontamination shall be assumed by the sub-licensee.

7. Deactivation/Reactivation of Radiation Use Areas - Should a sub-licensee foresee a period of time in which he/she does not plan to use radioactive material or radiation producing equipment in a particular laboratory(s)the affected laboratory(s) may be deactivated, though maintaining a valid sub-license, by meeting the following criteria:

a. A letter of intent to deactivate an authorized radiation use area will be submitted to the **RSO**. This letter will include:

(1) The room number(s) and diagram of the laboratory(s) to be deactivated.

(2) A statement that all radioactive materials used and/or stored in the affected laboratory(s) will be removed. If radiation producing equipment is involved then the statement shall be that all involved equipment in the affected laboratory(s) will be secured against any use. The radioactive material may be transferred either to the **RSO** for storage or disposal, or transferred, upon coordination through the **RSO**, to another sub-licensee who is authorized to possess the materials and activities under consideration, without exceeding his/her sub-license limits, or makes application to the **RSC** to amend the isotopes and activities.

(3) The sub-licensee will provide copies of the results of an IN-DEPTH contamination survey of the laboratory's, equipment, storage and waste areas to be deactivated. If excessive contamination levels are found, the contaminated areas and/or equipment will be decontaminated until allowable limits are reached.

(4) Upon receipt of the letter of intent, the **RSO** will perform a close-out survey of the affected areas and equipment.

(5) Based on a review of the letter of intent, the results of the close-out survey, and the disposition of the radioactive material or radiation producing equipment, the **RSO** will make his recommendations to the Chairperson of the **RSC** who, in turn, will authorize deactivation of the laboratory(s).

(6) Upon deactivation, all signs and labels, indicating that the areas were authorized for use of radioactive material, or radiation producing equipment shall be removed. Areas with radiation producing equipment may or may not qualify for unrestricted use, if equipment is still in use that produces ionizing radiation.

(7) At this point, further use of radioactive material and/or radiation producing equipment is strictly prohibited.

(8) All equipment and personnel monitoring equipment (i.e. survey meters, shielding, film badges, etc.) not belonging to the deactivating sub-licensee will need to be returned at this time.

(9) The term of deactivation of an authorized radiation use area will be a MINIMUM OF SIX (6) MONTHS AND A MAXIMUM OF UP TO TWO (2) YEARS (or until the sub-license is due for renewal). At the end of a deactivation period the sub-license may request, in writing, to renew the deactivated status of the laboratory(s) for another term.

(10) During the period in which a radiation use area is deactivated, the sub-license will remain in an active status. If all laboratories of a sub-license have been deactivated, the sub-license will require only minimal maintenance, i.e., periodic renewal and changes in radiation worker status. If there are still active laboratories on the sub-license, all current rules, regulations and policies governing that sub-license (relative to the active laboratories) remain in effect. Since deactivated laboratories are no longer considered radiation use areas, the requirements for periodic surveys no longer applies. However, the sub-licensee is still responsible for the retention of ALL records and files which were generated for that laboratory(s) while it was an active radiation use area.

(11) A sub-licensee may REACTIVATE a laboratory(s) any time he/she desires AFTER the initial six month period if the following criteria are met:

- (a) A written request to reactivate a radiation use laboratory(s) must be made to the **RSO**.
- (b) A diagram of the laboratory(s) must accompany the request, indicating radiation work areas, storage areas, waste container location, "hot sinks", etc. A laboratory will be reactivated ONLY under the initial conditions and configuration at the time of its deactivation. Any changes in work areas, storage areas, etc. must be made by amendment application AFTER the laboratory has been reactivated.
- (c) The **RSO** will review the request and inspect the laboratory area(s) and make his recommendations to the Chairperson of the **RSC**.

(d) After the Chairperson has approved the reactivation of a radiation use area it will, again, be subject to the posting, required records, safety procedures, and survey/safety check requirements as stipulated by state, federal, and Local TTU regulations and policies.

(e) At this time, radioactive materials and/or radiation producing equipment may again be used and stored in that particular laboratory(s). However, the radiation producing equipment will be subject to a survey conducted by the **RSO** to ensure the unit(s) meet all state and local requirements for radiation levels.

8. General Services For Radiation-Use Laboratories - All laboratories must be surveyed (wipe tests and visual inspection) for any possible radioactive contamination within 24 hours of the scheduled cleaning or other services. The lab shall remain clean until after the services, and it is the responsibility of the sub-licensee to assure this. Records of these surveys must be kept. Unacceptable removable contamination or radiation exposure rates will result in the suspension of general services. Supervision by the sub-licensee, a worker on that sub-license, or radiation safety personnel is required during all services with the exception of after hours, routine, custodial services.

Any laboratory found (during routine inspections) not to be performing required periodic surveys will be suspended from general services.

9. Custodial Service for Radiation Use Areas

a. To obtain special custodial service (i.e., scrubbing, stripping, and finishing floors), call Custodial Services (744-1866).

b. Prior to scheduling the cleaning, the following preparations must be made:

(1) The floor must be cleared of all obstacles such as boxes, books, containers, and radiation-labeled items. This must be done by authorized personnel . Visual surveys of the lab must accompany the wipe tests.

(2) Custodial Services will schedule the work and call to confirm the date with the requester.

(3) The custodians will leave a checklist in the laboratory. The checklist must be completed and signed by the lab personnel.

(4) Radiation laboratories requesting cleaning service will be furnished with a Request for Custodial Service door card. The **door card must be signed by the sub-licensee** or **RSO**, and left on the outside of the door on the day the work is to be accomplished.

(5) The sub-licensee or a worker on that sub-license **IS required** to be in the lab during the cleaning.

c. To obtain routine custodial service, call Custodial Services (744-1866) to receive a door card. Routine custodial service includes only sweeping floors, empty trash containers, and replace paper in paper dispensers.
(1) The Sub-licensee will simply complete, sign and date a door card.
(2) Place the card on the outside of the laboratory door before 6:00 PM on the day of the routine cleaning. These cards are only good for one day. These cards assure the custodians that there are no radioactive items with which they might come in contact.
(3) The sub-licensee or a worker IS NOT required to be in the lab during the routine cleaning. Routine cleaning will probably be scheduled between 6:30 PM and 8:00 PM.

10. Building, Maintenance And Construction (BM&C) Services

a. The **RSO** or sub-licensee can give clearance for BM&C to perform work in an authorized use/storage area. The laboratory must be surveyed within 24 hours of the scheduled work.

b. All "hot" items (marked with rad tape) to be serviced must be surveyed and cleared prior to the requested work to be done. The items must be released by the **RSO**, or documented and released by the Sub-licensee.

c. The sub-licensee or a worker IS required to be in the lab during the BM&C services.

11. Other Services

a. Departmental technicians can occasionally enter and perform routine duties provided they do not handle "hot" (labeled with radiation tape) items, and provided they are granted permission by the Sub-licensee.

b. Company technicians and servicemen servicing or checking items in authorized it must have the permission of the **RSO**. The Sub-licensee will be required to the lab surveyed within 24 hours of their visit. All "hot" items that will be serviced must be checked, and cleaned and rechecked if necessary. Records of these surveys must be kept.

c. The sub-licensee or a worker IS required to be in the lab during the services.

12. Portable Moisture Density Gauges (neutron probe) - (often referred to as Neutron Meters, Neutron Probes, PMDG's, etc.)

a. These policies and procedures shall apply to all portable devices using the thermalization of neutrons to measure water contents of porous materials or gamma rays for density measurement of specific materials.

b. In addition to the Texas Regulations for the Control of Radiation, the following policies and procedures will apply to the TTU license:

(1) Each PMDG located at TTU will have a designated authorized user who is responsible for safe storage, scheduling and preventive maintenance. Hereafter, this individual is known as the primary authorized user.
(2) Subject to the discretion and scheduling of the primary authorized user, other as to isotope and activity.
(3) The primary authorized user should establish a log to be kept at the location for permanent storage of the specific PMDG.
(4) It is the responsibility of the authorized user to:
  (a) enter notations in the PMDG log as to the date, time of day, the authorized users name and destination. Date and time will be logged upon return of the PMDG to permanent storage.
  (b) determine that the individual user has been approved for using that type of radiation equipment by the TTU Radiation Safety Office.
  (c) determine that the PMDG is in operating condition before it is removed from the vicinity of the permanent storage area. If the PMDG should become inoperable while it is in the custody of an authorized user, it is that user's responsibility to repair the PMDG expeditiously.
  (d) assure all necessary paper work such as a Bill of Lading, etc. accompanies the PMDG during transport. All paper work must be in the cab of truck, or glove box of car, NOT in the PMDG transport box.
(5) PMDG's may be temporarily transferred from other agencies for use by TTU personnel on TTU property. However, the transfer must be coordinated in advance through the **RSO**.
(6) The PMDG will always be stored and transported in its DOT approved storage box. When transporting the probe on public highways in the open beds of pickups and trucks, the case will be anchored securely.
(7) Personnel monitoring badges shall be worn during transport and use of the PMDG.
(8) The **RSO** shall be notified before any PMDG is released for repair.

NOTE: Should the PMDG become lost, stolen, lodged in a monitoring tube, etc., notify the **RSO** immediately. If lodged, DO NOT try to retrieve the probe, wait for **RSO** supervision.

(9) All PMDG's are required to have semi-annual leak tests and are to be included in semi-annual radioactive material inventories.

c. These procedures do not change the responsibilities either for the authorized or individual users, as outlined in other sections of this guide to Policies and Procedures for Radiation Protection at TTU.

13. Radioactive Material in Animals - The following procedures are to be used by researchers using radioactive materials in animals.

a. Prior approval to use animals in research shall be obtained by application or amendment through the **RSC**. Procedures must be outlined in detail showing activities, disposal procedures, surveys, potential problem areas, etc..

b. Policies concerning animal use:

(1) Animal cages are to be labeled with warning stickers.
(2) After sacrificing the animals the researcher or his technician shall wrap the animals in some type of absorbent paper, the animals shall then be placed in double bags (provided by **RSO**).
(3) All bedding and food shall be placed separately in double bags.
(4) The bags should be sealed with yellow tape and SHALL BE labeled with the following information:
  (a) Isotope
  (b) Total microcuries
  (c) Date of administration
  (d) Total gram weight

NOTE: Bags and tape shall be kept near animal housing.

(5) The animal carcasses, bedding, and food shall be stored in a freezer until Radiation Safety Personnel receive it for disposal.
(6) At least 24 hours notice shall be given to Radiation Safety for a pick up time.
(7) Contaminated cages, feeders, and water bottles must be washed separately from normal cleaning. If a suspended rack is used then the entire unit must be cleaned. NOTE: Gloves are to worn during cleaning operations and disposed of as radiation waste.
(8) Surveys shall be performed and recorded in accordance with Item D of this section.
(9) All cages, feeders, racks, and water bottles must be demonstrated to be free of contamination, by the researcher, to the **RSO**.

14. Radioactive Waste Disposal Program

a. General - Radioactive Waste materials which includes solid, bulk liquid, liquid scintillation vials, and animal carcasses resulting from the use of radioactive material

in laboratories shall be stored in designated containers and retained for collection by the **RSO**. All radioactive wastes shall be disposed of in such a manner as to prevent the occurrence of a hazard to the health of TTU personnel, to the value of property, and to the welfare of the public. Final disposal of all radioactive wastes, with the exception of trace amounts through the sanitary sewer system , will be accomplished by the **RSO**.

b. Waste Types - There are basically four types of waste generated at TTU: dry solid, bulk liquid, liquid scintillation vials (LSV), and animal carcasses. Although some predetermined operations may develop gaseous wastes.

(1) **Dry solid wastes** containing radioactive materials are nonhazardous or hazardous. Dry solid radioactive waste that contains a hazardous component (mixed waste) cannot be generated without permission from the **RSC**. Otherwise, all dry solid waste must be in the chemical form that is nonhazardous and acceptable for disposal in the Lubbock Municipal Landfill.

(2) **Liquid wastes** are separated into two categories: (1) aqueous bulk liquids and (2) mixed waste (organic) bulk liquids.

(3) **Aqueous liquids** are bulk liquids with a pH between 5 and 9, and which contain no biological, pathogenic, or infectious material, and have no hazardous characteristic. Aqueous biodegradable scintillation cocktails fall within this category. NOTE: Organic non-biodegradable scintillation fluids, hazardous liquids, as well as oils, other organic fluids, strong acids and bases are NOT considered aqueous fluids and should never be mixed with them.

(4) **Mixed (organic) bulk liquids** are radioactive bulk liquids that contain a hazardous component and meet the characteristics of hazardous material. Bulk liquids are considered mixed if they consist of hazardous chemicals such as toluene, xylene, or other flammable, toxic, or reactive fluids. NOTE: Regulations mandate that the generator (sub-licensee) be able to verify the contents of all wastes and their associated hazard classification.

(5) **Liquid scintillation vials** are glass or plastic vials with a capacity of less than 50 ml each which contain, or have contained, liquid scintillation fluid. Biodegradable scintillation cocktails such as Opti-flour, Aqua-sol, Ready-Safe, etc. should be used unless there is absolutely no way to avoid using the nonaqueous scintillation cocktails. NO blood or aqueous non-scintillation vials are to be placed in the LSV containers. Stock solution vials (NEN, ICN, etc.), liquid scintillation counter standards, or vials with non-scintillation fluids are not acceptable in LSV containers. NEVER mix dry solid or biological wastes in LSV containers.

NOTE: If any non-scintillation material is found in a LSV container, the container will be returned, or if found during an inspection the generator will be responsible for correction of the situation. If the hazard is considered not in the best interest of ALARA the generator may be held

responsible for additional broker or disposal sites. Flagrant or repeated violations will be reported to the **RSC**.

(6) **Animal carcasses** - This would consist of any animal used and/or sacrificed (during research) that contains radioactive material. This would include all parts of these animals (e.g. body, internal organs, etc.).

c. Responsibilities of the Generator (sub-licensee):

(1) Proper collection and storage of all radioactive waste.
(2) Compliance with state and local regulations and control of the wastes until removal by the **RSO**.
(3) Insurance that all radioactive waste materials are separated according to (liquid, scintillation vials, or dry solid) and(less than 300 days and greater than 300 days).
(4) Completion of all necessary paperwork prior to removal of wastes by the **RSO**. NOTE: The **RSO** will not pickup wastes without completed paperwork (Form RS-14A).
(5) The generator shall not at any time permit the disposal of radioactive material or radioactive waste into general waste pathways, other than trace amounts into the sanitary sewer system.

NOTE: If one wishes to retain and re-use glassware containing radioactive material the following procedure shall be followed:

- Pour off radionuclide(s) into an approved storage bottle.
- Rinse and pour this into the waste storage bottle.
- Repeat Step 2.
- Further rinses may be placed in the sewer followed by an adequate dilution of tap water in a designated and labeled sink only.

(6) Regardless of the frequency of disposal and the individual concentrations, the total activity disposed into the sewer by each individual sub-licensee SHALL NOT EXCEED ONE uCi PER DAY.

d. Laboratory Waste Handling and Storage

(1) The **RSO** will provide small sturdy cardboard boxes (i.e., 10"x10"x15") and 4 mil plastic bags for dry solid wastes and animals, and polyethylene carboys (2.5 to 5 gallons) for liquid waste. These containers shall be labeled with "radioactive material" labels.
(2) Wastes will be separated by the generator and stored according to physical form (dry solid, animal, liquid, scintillation vials) and half-life (less than 300 days and greater than 300 days). Chemically hazardous wastes should be held to a minimum.
(3) Wastes must stored only in restricted areas where they can be secured against unauthorized removal.

(4) Liquid wastes shall be stored in unbreakable polyethylene carboys and provided double containment.
(5) Aqueous liquid wastes shall be neutralized prior to deposition in a waste container to prevent any violent or hazardous chemical reactions.
(6) Each laboratory having radioactive waste containers shall display a "radioactive waste" sign in the area designated for radioactive waste.
(7) Any material that could cause puncture of the skin (i.e. syringe needles, broken glass, razor blades, etc.) shall be placed in puncture-resistant containers and labeled as such before placement into dry solid containers.
(8) ALL radiation labels, signs, tape, symbols, etc. indicating there is or was radioactivity in the waste shall be removed or defaced BEFORE placing waste in dry solid container [reference **TAC §289.202(cc)(2)**].
(9) All animal carcasses and parts thereof containing radioactive material or contaminated with radioactive material shall be stored frozen.
(10) Waste Records are required to assure that the radionuclides and activities determined for the disposal purposes of each container are accurate. An inventory log sheet (developed by each sub-licensee) or the radioisotope use form on or near waste receptacles is a practicable way to account for the contents. NOTE: It is the responsibility of the generator to keep an accurate isotope and activity log for each waste container. Routine pickups, inspections and record keeping audits by the **RSO** are used to evaluate a generators (sub-licensee) waste management controls.

e. Animal Carcasses and Waste - Animals sacrificed containing radioactive material shall be prepared and stored frozen. The sub-licensee is responsible for the storage (frozen) of the animals until such time that the **RSO** can arrange for animal disposal through a contracted radioactive waste broker or landfill disposal according to procedures accepted by **TAC** requirements.

f. Waste Pickup

(1) Request for removal of radioactive waste from the lab by radiation safety may be made by telephone to the **RSO**.
(2) The generator (sub-licensee) will be responsible for accurately filling out the "Request for Radioactive Waste Disposal" form (Form RS-14A). This form is available from the **RSO**. The form details information needed for accurate disposal of the waste. Each type of waste (physical form) will require a separate form.

NOTE: Wastes <u>will</u> <u>not</u> be picked-up without this form filled out completely and signed by the generator. It is the responsibility of the generator to indicate any known or suspected hazardous characteristics. This would include ignitability, corrosiveness, reactivity, toxicity, or other hazardous characteristics.

(3) NO radioactive waste having biohazardous characteristics shall be released from a laboratory for pick-up prior to autoclaving or otherwise suitable deactivation of any infectious agent(s).

g. Sanitary Landfill Disposal - Certain radionuclides may be disposed of in a Type I municipal solid waste site such as the City of Lubbock Landfill (permit #69) by the TTU Radiation Safety Office as authorized by the Bureau of Radiation Control. The radionuclides authorized for disposal are the less than 300 day half-life isotopes listed in the appendix of **TAC §289.202**, and can be disposed of in a Type I municipal solid waste site provided that the waste is dry and non-hazardous and the concentration and activity limits specified in **TAC §289.202** are not exceeded. Non-hazardous dry waste from in vitro clinical or in vitro laboratory testing containing 0.05 microcuries or less of Hydrogen-3 (tritium), Carbon-14, or Iodine-125 can be discarded without regard to its radioactivity; this waste should be physically delivered to the landfill. Animal carcasses containing 0.05 microcuries or less of Hydrogen-3, Carbon-14, or Iodine-125, per gram of animal tissue per animal can be disposed of without regard to its radioactivity. Disposal of ANY of the waste described above will be allowed provided:

(1) The disposal is approved by the Bureau of Radiation Control and the Texas Natural Resource Conservation Commission, and is in compliance with all requirements of **TAC §289.202** and other applicable regulations.
(2) The burial is made a matter of record by listing the activity, radionuclides, biological materials, date, and name of the individual supervising the burial.
(3) Tissue in animal carcasses are frozen.
(4) The burial is coordinated with landfill personnel at least 24 hours in advance.
(5) The waste material is transported to the burial site by an individual familiar with the concepts of radiation safety and is authorized by the **RSO**.
(6) The authorized individual will not leave the burial site until they are assured that all animal waste materials are covered by a minimum of four feet of **fill**.

h. Disposal Through Natural Decay - The Radiation Safety Office is the only entity at TTU authorized to supervise long term retention of radioactive material for the purpose of decay. After retention for a suitable time interval (several half-lives), the **RSO** shall evaluate the remaining activity and properly document the evaluation. If the evaluation demonstrates that the activity(s) are below the "exempt quantities of concentrations" [reference **TAC §289.202(ggg)(3) – Table III**], the **RSO** may authorize the disposal of the material as conventional waste, provided all radioactive material labels, symbols, etc. are removed and the waste contains no hazardous characteristics.

i. Sanitary Sewerage Disposal

(1) The Radiation Safety Office is the only entity at TTU authorized to dispose of radioactive materials through the sanitary sewer.
(2) All sanitary sewer disposals shall be in accordance with **TAC §289.202(gg)**. Furthermore, these disposals shall be made a part of the **RSO's** disposal records.
(3) Any liquids containing radioactive material with hazardous characteristics will not be disposed of by this manner. These will be disposed of as mixed waste or hazardous waste.

j. Other Disposal Information

(1) The generator (sub-licensee) is responsible, upon receipt of the isotope, for recording the use and recording the disposal of radioactive material on the Radioactive Material Use Form (Form RS-14).
(2) The generator (sub-licensee) shall maintain copies of all disposal forms with other required record keeping.
(3) Tritium (^{3}H) stored in a closed plastic bag will produce HTO and be released through the plastic. Tritium contaminated objects should be temporarily stored in an open tray pending placement in a waste disposal barrel.
(4) Lids shall remain on <u>all</u> waste containers at all times.
(5) Plans for proper disposal of infectious agents or highly toxic or hazardous substances shall be made early in the design stage of the experiment. Proposed procedures involving unusual waste disposal problems will be considered individually by the **RSC** and/or the **RSO**.
(6) The **RSO** shall maintain proper disposal records for all TTU campus-wide radioactive waste disposals in accordance with the **TAC §289.202**.
(7) Bulk liquid waste that contains greater than or equal to 75% water, less than or equal to 15% methanol, less than or equal to 10% acetic acid, and a less than 300 day half-life radioisotopes (i.e., S-35 and P-32) may be stored and decayed. After the radioisotope component has decayed, the liquid may be tested for its hazardous characteristic and then disposed of accordingly**.**

15. Additional Policies and Procedures

a. Radioactive Materials Use

(1) **Proper marking of laboratories, areas, and equipment.**

(a) A "CAUTION RADIOACTIVE MATERIALS" sign must be conspicuously posted on the doors to laboratory areas where radioactive materials are being used or stored in accordance with **TAC §289.202(z)** and **§289.202(aa)**. The signs must not be removed from any room except by the **RSO** following a deactivation or termination inspection or survey.

(b) Storage areas shall be conspicuously marked with a "CAUTION RADIOACTIVE MATERIALS" label. This label shall also state the isotope activity and date.

(c) A "CAUTION RADIATION AREA" sign(s) shall be posted for any area where radiation levels could result in an individual(s) to receive a dose equivalent in excess of 5 millirem in any one hour at 30 cm from a radiation source or surface from which radiation penetrates.

(d) A "CAUTION HIGH RADIATION AREA" sign(s) shall be posted for any area where radiation levels could result in an individual(s) to receive a dose equivalent in excess of 100 millirems in any one hour at 30 cm from any source of radiation or from any surface from which radiation penetrates.

(e) All equipment contaminated with radioactive material shall be marked with signs, decals, or other conspicuous means. Equipment labeled as contaminated SHALL NOT be removed for unrestricted use, disposal, or transfer as uncontaminated. Labeling will not be required of equipment used transiently in laboratory procedures during the presence of the user.

(f) All radioactive refrigerators and freezers shall be posted with "Caution Radioactive Material" labels and "Food Must Not Be Stored In This Refrigerator" labels.

(g) All signs needed for proper labeling of the laboratory are available from the Radiation Safety Office. All sub-licensees are responsible for equipment, source, and area labeling tape, as well as work area absorbent paper, and any other specialized signage needed.

(2) **Shielding of Sources**

(a) Radioactive sources or stock solutions in the laboratory shall be shielded in such a manner to keep exposures ALARA, never to exceed 100 mrem in any five consecutive days.

(b) A beta shield will be required for procedures involving greater than 1 mCi of P-32.

(c) Proper shielding materials shall be obtained by each sub-licensee for his/her particular use so as to comply with Item a. (above). Various shielding materials (limited supply) are available on temporary loan from the Radiation Safety Office.

(3) **Aerosols, Dusts, and Gaseous Products**

(a) Procedures involving aerosols, dusts, or gaseous products, or procedures which might produce airborne contamination shall be conducted in an approved hood, dry box, or other approved closed system.

(b) All releases from such systems into the work place shall not exceed 10% of the applicable annual limit on intake (ALI) listed in **Columns 1 and 2 of Table I of TAC §289.202(ggg)(2)**. However, when practical, traps should be incorporated to ensure that environmental releases are ALARA.

(c) Radioactive gases or materials with radioactive gaseous daughters must be stored in gas tight containers and must be kept in areas having approved ventilation.

(d) Microcentrifuge tubes placed in heat blocks must be done within a hood if the activity of the isotope in the microcentrifuge tube is >20 uCi. I.E., if there are 10 tubes per heat block, then the total activity must be ˙20 uCi for this procedure to be performed in the open.

b. Gas Chromatographs

(1) Radioactive material in gas chromatography units (GC) shall be regulated the same as any other radioactive material at TTU.

(2) In addition, each gas chromatograph containing a radioactive foil must have a label showing the radiation caution symbol with the words "Caution Radioactive Material:, and the type and activity of the radioactive material.

(3) The radioactive foil shall not be removed or transferred from its identifying cell or laboratory without prior **RSO** approval.

(4) The sub-licensee shall post the following notice on the outside of each gas chromatograph unit: "This equipment contains a radioactive source registered with the Depart of Environmental Health and Safety. Notify the Radiation Safety Office before removing the source from this equipment or area, or upon change in are responsibility."

(5) Individuals using radioactive material components in gas chromatography equipment must vent the cell exhaust through plastic tubing into a hood, or radiation safety approved trap to avoid contamination of work areas from the release of radioactive tagged samples introduced into the system.

(6) The **RSO** will perform leak tests at the minimum of every 6 months, store radioactive foils, and maintain necessary records.

c. Sealed Sources: Sealed sources of radioactive material, unless otherwise noted in this manual shall be tested for leakage of radiation on a semi-annual basis [reference **TAC §289.201**].

d. Use of Hoods

(1) Hoods used for radioactive work should be tested by the Department of Environmental Health and Safety to insure the fume hood meets the minimum requirements for air velocity at the face of the hood.

(2) Hoods should be checked at least annually for radioactive material contamination by performing a smear survey of the interior and if P-32 or I-25 are used in the hood, a scan with a survey meter should be performed.

(3) No more than 10 mCi of any volatile isotope should be used in a hood without first contacting the RSO.

I. Safety Procedures for Individual Users and Workers Using Radiation Sources Under Sub-licenses

1. Each individual user shall work under an Authorized Sub-license and SHALL use the following procedures to assure safety in the work environment and compliance with TTU's radiation safety policies and practices:

a. ALL users of radiation sources SHALL fulfill TTU's radiation safety training requirements PRIOR to using radiation sources.
b. Radiation exposure of all individuals shall be maintained ALARA.
c. The prescribed personnel monitoring devices (such as film badges and pocket dosimeters) SHALL BE WORN in radiation areas and while using radiation sources.
d. Personnel monitoring devices shall be protected from inadvertent exposure and damage and shall be returned to the Radiation Safety Office as scheduled.
e. When working with unsealed radioactive material, the user's hands, shoes, clothing and body SHALL be surveyed for radioactive contamination. at the conclusion of the work (Note: periodic surveys should be performed during operations using radioactive materials).
f. If radioactive contamination is detected on an individual's hands, shoes, clothing or body, the contamination will be removed before the individual is permitted to leave the restricted or laboratory area.
g. The following protective equipment shall be worn, and protective procedures followed, at all times when working with radiation sources:
(1) wear protective clothing, gloves, and (in some cases) shoe covers when working with unsealed radioactive materials;
(2) using protective barriers and shields whenever possible -- also protective eyewear if laser hazards exist;
(3) use mechanical devices (tongs, remote handling tools, etc.) to assist in reducing exposure;
(4) perform all work with radioactive materials within the confines of an approved fume hood or glove box – except where a safety review has determined it is safer to work in an open area;
(5) **PIPETTING BY MOUTH IS STRICTLY PROHIBITED** when working with radioactive materials AND/OR with chemically and biologically hazardous substances; and
(6) **respiratory protection** may NOT be used as a safety function. [**Note:** *Procedures involving radioactive materials that rely on respiratory protection devices require specific approval from the Bureau of Radiation Control, Texas Department of Health. Approval will require participating individuals to receive training in use of respiratory protective devices, passing a respiratory physical, and fit testing by the Environmental Health and Safety Office*].

h. Eating, drinking, smoking, applying makeup, etc. in radiation laboratories and areas where unsealed radioactive materials are stored or used is strictly PROHIBITED.
i. Radiation use and storage areas SHALL NOT be used jointly for storage of radioactive material and material for human consumption.

j. Each user shall maintain good personnel hygiene and occupational safety habits (such as not working with radioactive material if there is a break, cut, scratch, etc. in the skin below the wrist and always washing hands and arms thoroughly before handling any object near the face.

k. Areas where radioactive material, radiation producing equipment, and/or lasers are used, shall be periodically surveyed and checked for contamination, excessive radiation levels (ionizing, non-ionizing), and proper operation of all warning devices and interlocks according to the procedures required in this manual. Records of these surveys and checks shall be maintained for review and inspection by the Radiation Safety Office and the regulatory agency.

l. Radiation use/storage areas, devices, and containers shall be periodically inspected for proper display of required warning signs and labels.

m. Each radiation use laboratory and work area:
(1) shall be maintained neat and clean;
(2) shall be free from unnecessary equipment and material:
(3) shall store and transfer/transport radioactive materials in a manner that prevents breakage or spillage (use double containers, for example);
(4) shall provide for adequate shielding;
(5) shall have work areas covered with absorbent material and/or stainless steel trays or pans to limit and collect spillage in case of accident.
(6) Laboratory equipment (such as glassware), stock radioactive material, and radioactive waste, shall be labeled and isolated appropriate storage facilities. Equipment that has been used in work with unsealed radioactive materials shall not be used for other work and shall not be sent from the area to central cleaning facilities, repair shops, or to surplus, until it has been demonstrated and certified by the Radiation Safety Office to be free of radioactive contamination.

n. Emergency repair of contaminated equipment by shop personnel or by commercial service contractors will not be performed except under the direct supervision of the RSO or his/her designee. Timely requests for such supervision shall be made to the RSO to allow for scheduling.

o. A member of the laboratory staff shall be present to provide specific information when service personnel are permitted to work on equipment in radiation areas.

p. Each user/individual SHALL:
(1) IMMEDIATELY REPORT accidental exposure, inhalation, ingestion, or injury involving radioactive materials, X-ray radiation, or laser radiation to his/her supervisor AND to the RSO;
(2) IMMEDIATELY conduct the required/recommended corrective measures and procedures – unless otherwise directed by the RSO. The individual(s) shall cooperate in any and all attempts to evaluate his/her exposure.
(3) Perform emergency decontamination procedures, when required or necessary, and take the necessary precautions to prevent the spread of contamination to other areas and equipment.

(4) Comply with requests from the RSO for bioassays, body burden measurements and/or the submission of urine samples for internal radioassay.
(5) Comply with the required procedures for handling radiation incidents. according to Section V - Emergency Procedures and TTU Operating Procedure 78.05 Vol.II.

J. General Laboratory Radiation Safety Rules – the following rules are to be used with the ALARA concept in mind. The TTU Radiation Safety Manual, in addition to the state and federal regulations and guidelines, are minimal requirements that are designed to enable ALARA controls and keep exposures well under the maximum limits. This list should be posted conspicuously in each laboratory area:

1. NO PIPETTING BY MOUTH

2. No open toed shoes (i.e. sandals, flip-flops, etc.) in radioactive material laboratories.

3. All radioactive material containers must be labeled as to isotope, activity, and date.

4. NO eating, drinking, smoking, food storage, application of cosmetics, or food preparation in radiation labs.

5. Place rad-waste in appropriately labeled waste receptacles.

6. NEVER mix different forms of rad-wastes.

7. Remove protective clothing and gloves before leaving radiation lab.

8. Monitor hands, shoes, and clothing before leaving radiation lab.

9. Personnel exposures shall be kept ALARA by using time, distance, and shielding safely and effectively.

10. Use the fume hood when needed.

11. perform all required surveys and safety checks.

12. All spills and accidents must be reported immediately to the RSO.. If you are unsure as to the proper course of action to take in any given situation, always consult your supervisor or call the Radiation Safety Office (742-3876).

END OF SECTION II

SECTION III – RADIATION PRODUCING MACHINE SAFETY PROGRAM

Introduction - This section will outline Policies and Procedures for radiation producing equipment. The equipment referred to will be analytical X-ray equipment, research accelerators, and other ionizing radiation producing equipment. These Policies and Procedures, established with the utmost concern for ALARA, are in addition to **Texas Regulations for Control of Radiation Parts 34, 35,** and other applicable regulations.

A. Radiation Producing Machines (X-Ray)

1. **Registration**: The Texas Regulations for Control of Radiation require that radiation producing machines be registered with the Bureau of Radiation Control, Texas Department of Health.
2. **Proposed devices**: Registration of proposed devices must be conducted through the **RSO**.

3. **Personnel Protection**
   a. **Personnel Monitoring:** All operating personnel and personnel in the immediate area shall wear a film badge or other personnel monitoring device, as supplied by the **RSO**.

   b. **Personnel Safety -** Personnel specifically responsible for such equipment shall:
      (1) used or to be used;
      (2) ensure that all rules and regulations (TTU, state and local) have been implemented and are followed;
      (3) ensure that all users have attended the TTU Radiation Safety Shortcourse (given by the **RSO**) for radiation producing equipment prior to using the radiation producing equipment.

4. **Facilities**
   a. **Posting and Labeling:**
      (1) **Areas:** Areas in which radiation producing equipment are located or are being used shall be posted with a standard "CAUTION – X-RAY RADIATION" sign.
      (2) **Devices:** The controls of each radiation producing device shall bear a label or decal with the statement: "CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED." Signs, labels and decals are available from the Radiation Safety Office.
   b. **Record of Operation:** A log book and a copy of the operating procedures (for that particular instrument or area) shall be attached to each instrument or near the control panel..

5. **Radiation Surveys And Record Keeping Requirements**
   a. **Sub-licensee Requirements:**
      (1) Radiation surveys:

         (a) Radiation surveys will be conducted after every change that might increase radiation exposure hazard.
         (b) Radiation surveys shall be conducted at least once a month.

(c) The results of each radiation survey shall be recorded in the log book
(d) Radiation surveys shall be performed using only the appropriate instrument.

(2) **Interlocks,** visual and audible warning devices, and shutter mechanism checks shall be conducted at the same time as the radiation surveys and the results shall be recorded in the log book.

(3) **Log book:** Each log book (record) shall contain the following information:
(a) Users log (user, date, start, finish, power settings)
(b) Survey Records (date, surveyor, instrument used, drawing or photograph of instrument/area, particular area surveyed, and results of the survey recorded in proper units.
(c) Safety device records (date, surveyor, drawing or detailed photograph of the instrument - indicating the location of the safety devices, results of the checks as to whether the devices were Operative (O) or Inoperative (IO).

(4) **Written Safety Procedures:**
(a) Safety and Operating Procedures shall be written and updated as changes in that particular instrument or area warrant the need for revision.
(b) The written safety and operating procedures shall be available to all users.

b. Radiation Safety Office Requirements

(1) A radiation survey of all radiation producing devices shall be conducted on a 6 month interval by the Radiation Safety Office.

(2) All interlocks, visual and audible warning devices, and shutter mechanisms shall be inspected for proper operation on a 6 month interval by the Radiation Safety Office.

c. Additional Rules And Requirements

(1) The **RSC**, upon recommendation of the **RSO**, may require additional safety devices or procedures (beyond the minimum TAC requirements) to ensure conformance with ALARA. The following criteria will be used to determine the need for additional safety devices or procedures:
(a) The number of persons involved with the use of the x-ray producing devices.
(b) The need to reduce the chance of any unneeded exposures.
(c) The amount of personnel traffic in and out of the lab.
(d) The age of the x-ray producing devices.
(e) The current safety devices in use.
(f) Number of x-ray producing devices located in a single area.
(g) Previous compliance during local and state inspections.
(h) Previous exposure reports.

(2) The structural shielding requirements of any new installation, or an existing one in which changes are contemplated, shall be reviewed with the **RSO**.

(3) No person shall be permitted to operate radiation producing equipment in any manner other than specified in the procedures unless such person has obtained written permission from the **RSO** and the RSC.

(4) No person shall bypass a safety device unless such person has obtained written permission from the **RSO** and the RSC.

(5) All log books and current Operating Procedures shall be readily available to each radiation producing device or near the control panel.
(6) Each sub-licensee must maintain portable radiation monitoring device(s) capable and calibrated for the measurement of X-ray radiation in beams of a small cross-section.
(7) The local components of any radiation producing equipment system shall be located and arranged and shall include sufficient shielding or access control such that no radiation levels exist in any area surrounding the local component group which could result in a dose to any individual present therein in excess of the dose limits given in this manual. These levels shall be met at any power rating.
(8) The **RSO** must be notified in advance of the procurement, transfer, or donation (received or given) of ALL radiation producing equipment, whether ionizing or non-ionizing: X-ray units, accelerators, or lasers.
(9) All radiation producing equipment shall be shipped to the following address:

ATTN: **RSO**
Central Receiving
Texas Tech University
Lubbock, Texas 79409

(10) Radiation producing equipment or lasers transferred within TTU must be coordinated with the **RSO**.
(11) The **RSO** shall be notified of any instrument taken out of use and placed into storage or to be disposed of.

B. Radiofrequency And Microwave Devices

1. Protection From Microwave Oven Radiation

a. Non-public use - (i.e. departmental, laboratory/research)

(1) **Registration** - Person(s) responsible for each microwave oven at TTU should notify the Radiation Safety Office of its presence.

(2) **Surveys** - The Radiation Safety Office will perform surveys of microwave ovens at TTU that are used for **non-public use** on a request only basis. In the event that the microwave oven is found to be leaking microwave radiation in excess of the limits specified in **TRCR Part 90.9 (a)(1),** the **RSO** (**RSO**) shall notify responsible person(s). Person(s) responsible for the defective oven should discontinue use until the oven is repaired and surveyed.

(3) **Repairs** - All repairs to defective ovens shall be performed by qualified repair technicians that can certify compliance with emission levels listed in **TRCR 90.9 (a)(1).** A completed Repair Certification label shall appear on all microwave ovens. This label shall include the name of the person certifying the compliance with emission limits, and signature of authorized agent and date.

b. Public-Use Microwave Ovens (i.e. Commercial food vending service) - Public use microwave ovens include any microwave oven or equipment offered for public use, or where public access to the use of the microwave oven or equipment is made available.

(1) **Registration** - The persons and/or companies responsible for each microwave oven at TTU should notify the Radiation Safety Office of its presence, and should have available survey records performed in accordance with **TRCR 90.5** for the previous three years.

(2) **Surveys** - The persons and/or companies responsible for each microwave oven at TTU shall ensure that each microwave oven meets the microwave oven standards established in **TRCR Part 90.9 (a) & (b)**. Compliance surveys of the microwave oven(s) as described in **TRCR Part 90** will be performed by the Radiation Safety Office. These measurements shall be performed semi-annually. The microwave oven(s) shall be labeled after every survey and the label shall include: the signature of the person performing the survey, and date of the compliance survey. The Radiation Safety Office, upon notification or discovery of a microwave oven not in compliance or without proper survey labeling or records, shall immediately shut down and discontinue the use of the microwave oven until the unit is determined to be in compliance.

(3) **Repairs** - All repairs to defective ovens shall be performed by qualified repair technicians that can certify compliance with emission levels listed in **TRCR 90.9 (a)(1)**. A completed Repair Certification label shall appear on all microwave ovens. This label shall include the name of the person certifying the compliance with emission limits, and signature of authorized agent and date.

(4) **Other Requirements** - As specified in **TRCR 90.0(b)** all commercial food service microwave ovens (i.e. public use) shall meet the National Sanitation Foundation Standards or be approved by the U.S. Food and Drug Administration or the Texas Department of Health.

(a) Microwave ovens or equipment brought on TTU property by outside vendors, food brokers, etc. shall meet all requirements of the **TRCR Parts 80 and 90**. Furthermore, the outside vendor, food brokers, etc. shall be responsible for repair, cleaning, and notification to the TTU Radiation Safety Office of relocation or new locations of microwave ovens for public use.

(b) The food contact and RF radiation sealing surfaces of the cavities of microwave ovens shall be cleaned at least once a day and shall be kept free of encrusted grease deposits and other accumulated soil (**TRCR 90.9 (b)(2)**).

(c) Where microwave equipment and utensils are used for food preparation of potentially hazardous foods on a continuous or production-line basis, utensils and sealing surfaces of equipment, shall be cleaned and SANITIZED at intervals throughout the day on a schedule approved by the regulating health authority. This schedule shall be based on food temperature, type of food, and amount of food particle accumulation. (**TRCR 90.9 (b)(3)**) For information concerning TTU cleaning and sanitization policies contact the TTU Department of Environmental Health and Safety at 742-3876.

(5) **Contact -** Any questions concerning standards for RF or microwave radiation not being produced in microwave ovens or exempt equipment should be addressed to the TTU Radiation Safety Office.

3. Safety Tips for Microwave Oven Users (published by the U.S. Govt. Bureau of Radiological Health)

a. Follow the manufacturer's instruction manual for recommended operating procedures.
b. Examine the oven for evidence of shipping damage.
c. Never insert objects (for example, a wire) through the door grill or around the door seal.
d. Never tamper with or inactivate the oven safety interlocks.
e. Never operate an EMPTY oven.
f. Clean oven cavity, door, and seals frequently with water and mild detergent. DO NOT use scouring pads, steel wool, or other abrasives.
g. Have oven serviced regularly by a qualified serviceperson and inspected for signs of wear, damage, or tampering.
h. Additionally, users of microwave ovens manufactured prior to the new standards (prior to October 10, 1971) should follow these precautions:
i. Switch the oven off before opening the door.
j. Stay at least an arm's length away from the front of an oven while it is on.

END OF SECTION III

SECTION IV – LASER SAFETY PROGRAM

This section is reserved for future presentation of LASER safety policies and procedures.

SECTION V - EMERGENCY PROCEDURES

Introduction - This section outline basic emergency procedures. An emergency situation or accident can arise from the use, storage, or transfer of radioactive material or from the misuse or abuse of equipment that produces X-ray radiation or other forms of ionizing or non-ionizing (i.e. laser) radiation. This section is intended to enhance each sub-licensee's and worker's ability to react properly to radiation accidents.

Due to the broad scope of possible accidents at TTU, listing every step that must be followed for each type of accident would be impracticable. Instead, one must use the following basic procedures and apply them to his/her individual situation. The best advice for protection against radiation or laser accidents is to prepare for them.

A. General Information - A radiation incident at TTU should be defined as any unintentional accident or any single exposure or suspected exposure in excess of 45% of the maximum allowable exposure as set forth in **TAC §289.202**, the ingestion of radioactive material in the form of liquid, gas, or dust in excess of limits set forth in **TAC §289.202(ggg)(2)**, any radioactive material spill regardless of activity and size, or accidents involving laser radiation exposure to the eyes or skin. **NOTES** - If persons involved in a radiation incident are unsure as to the extent of exposure, ingestion, or magnitude of the spill, those persons shall proceed with the assumption that an overexposure (internally or externally) or major spill has occurred, unless otherwise noted. Users will report all radiation incidents.

B. Organization And Authority

1. The responsibility of incident investigation shall be that of the **RSO**.
2. The **RSO** will promptly report all investigation findings to the **RSC** and to the Agency [reference **TAC §289.202(xx)**] for direction and action.
3. If preliminary findings of an incident presented to the **RSC** indicate there is probable cause of neglect or violation of state, federal, or local regulations or policies, the sub-licensee involved will be asked to attend the next **RSC** meeting to answer questions and present his/her account of the incident.
4. In the event of a major emergency situation the **RSO** shall have the authority to bring the situation under control. It should be noted that this may not follow the TTU Administration Organization Chart. However, if this will only be used in extreme emergencies where this is immediate radiological danger to individual(s) or possible major building contamination.
5. It is the responsibility of each sub-licensee to see that personnel working under their supervision have practical and well understood plans for an emergency, and control of an emergency in their respective laboratory. (reference TTU - Operating Procedure 78.01 Vol.III)
6. The **RSO** has the responsibility to see that each radiation sub-licensee/worker knows how to:

    a. Recognize a radiation or laser emergency.
    b. Prevent or confine the accident.
    c. Exclude all personnel from possible risk of exposure.

d. Immediately contact his/her supervisor, the **RSO**, and/or other emergency personnel for assistance.

7. Each sub-licensee will be responsible for assisting the **RSO** in controlling and/or investigating the accident. Furthermore, the sub-licensee is responsible for assisting the victim(s) in getting medical attention, if necessary, as soon as practicable.

C. Fires, Explosions, Or Major Emergencies

1. Notify all persons in the area to leave at once.
2. Notify the TTU Fire Marshall, Lubbock Fire Department, the **RSO** as well as other supervisory personnel. Give them the address and the location of the fire.
3. If firemen arrive before the **RSO**, caution them that radioactive material is present in the area. Be ready to advise them on location, isotope(s), activity(s), type of storage, and any other information that may be needed to avoid radioactive contamination of personnel, building, or equipment.
4. The sub-licensee and/or workers will need to be available to evaluate or help evaluate the extent of damage to radioactive material and/or survey emergency personnel and equipment for radioactive material contamination.
5. All sub-licensees and workers will be required to file an incident report with the **RSO**.
6. **MINOR FIRES** - If the fire is minor (individual decision) and there are no radiation or chemical hazards involved, a sub-licensee or worker may attempt to put out the fire with approved fire fighting equipment.

D. Accidents Involving Possible Radiation Overexposure - If a radiation overexposure has occurred, or is suspected to have occurred, proceed as follows:

1. Immediately remove affected person(s) from the area and **notify the RSO**.
2. Secure the area.
3. Take the affected persons(s) to the nearest emergency center immediately for clinical observation. Be sure to inform the attending medical personnel that it is a radiation accident. Be prepared to answer any questions that may arise concerning the accident or type of radiation involved.
4. Assist the **RSO** in obtaining all details of the incident.
5. The **RSO** will obtain the dosimetry of all involved person(s). The **RSO** will then forward the dosimetry for emergency processing.
6. Persons involved in the incident will not be permitted to work with radiation until exposure results have been received and the **RSO** has determined that exposure limits have not been exceeded.
7. The **RSO** will provide reports to the RSC and regulatory agencies.

E. Accidents Involving Significant Releases Of Radioactive Materials

1. Notify all other persons in the area of the accident.

2. If possible, hold breath and close all air vents.
3. Vacate the room and seal off the area, if possible.
4. Notify the **RSO** immediately.
5. Secure access to the area.
6. Monitor all involved persons for contamination.
7. Assist and/or submit to any bioassay deemed necessary by the **RSO**, **RSC**, or the **BRC**.
8. Assist the **RSO** in hazard evaluations and decontamination procedure.

F. Personnel Injuries - Persons should not work with uncontained radioactive material when they have a break in the skin (cut, scrape, etc.) below the wrist. If a person is cut by an article contaminated with radioactive material the following should be used as a guide:

1. Cleanse the wound immediately by placing it under running water. If possible, retain any cotton balls, paper towels, fluids, etc. for radiological analysis. Contact the **RSO** as soon as practicable.
2. If necessary take the person(s) for emergency treatment. Be sure to tell the attending medical personnel that radioactive material was involved in the accident.
3. Follow the necessary steps in Item D of this section, under the direction of the **RSO** and/or **RSC**.
4. Contact the **RSO** before proceeding with more severe methods of decontamination.

G. Policies For Radioactive Spills – The following procedures are a generalized summary of procedures listed in NCRP REPORT 48 and ICRP Report 28:

1. **Minor Spills** (i.e. at the microcurie level)
   - **a.** Notify other persons in the laboratory and minimize radioactive material ingestion, inhalation, etc.
   - **b.** Prevent the spread of contamination of the accident.
   - **c. Contact the RSO.**
   - **d.** Survey all persons involved, decontaminate if necessary, and release unneeded persons.
   - **e.** Begin decontamination procedures.
   - **f.** Submit incident report to the **RSO**.

2. **Major Spills**
   - **a.** Notify all persons in the laboratory and minimize radioactive material ingestion, inhalation, etc.
   - **b.** Prevent the spread of contamination of the accident.
   - **c.** Contact the **RSO**.
   - **d.** If possible, block all air vents to avoid creation of airborne contamination.
   - **e.** Vacate the laboratory, avoid spreading the contamination.
   - **f.** Survey all persons involved, and decontaminate if necessary. Do not release persons directly involved, except for emergency medical treatment. Wait for the **RSO** and/or the RSC to authorize release.
   - **g.** If deemed necessary by the **RSO** and/or **RSC** specific steps in Items D. E., or F. of this section may need to be initiated.

H. Loss Or Theft Of Radiation Equipment

1. Any loss or theft of radioactive material, a device containing radioactive material, or a radiation producing device ,shall be immediately reported to the **RSO**.
2. The **RSO** will provide required notification to the Bureau of Radiation Control.
3. The **RSO** will determine the extent of damage and analyze the recovery plan.

NOTE – Repair of any encapsulated radioactive material source IS PROHIBITED. Radiation sources involved in an accident, fire, flood, etc. MAY NOT BE USED until tested by the **RSO** and found to be in proper and safe operating condition.

I. Malfunction Of Radiation Producing Equipment

1. Any radiation device (X-ray, PMDG, Laser, etc.) believed to be defective shall be locked into a safe position and made inoperative immediately. In emergency situations the individual user, authorized user, and/or the **RSO** can take such action as to shield the source, deactivate the equipment, or retrieve the source.
2. The responsible user must restrict access to the area until the **RSO** arrives.
3. The **RSO** will evaluate the incident thoroughly, notify the **RSC** in writing within 10 days and if necessary report the incident to the BRC within 30 days.

J. Vehicle Accident During PMDG Or Ram Transportation - If a vehicle accident occurs during the transportation of a PMDG or radioactive material and there are no fires or injuries the following procedure should be used:

1. If a minor accident and it can be visually determined that the source is safely stored in its DOT container then no restricted area is required, otherwise establish a safe perimeter around the source assuming the source is in an exposed position.
2. If a survey meter is available, and no radiation hazard exits, and the vehicle is movable proceed to destination.
3. If the source cannot be found, does not appear to be safe, vehicle is not moveable, etc. have a responsible person notify the **RSO** and/or the BRC. Then proceed to isolate the vehicle and area.
4. Other areas of the Emergency Procedures may need to be instituted before the **RSO** or emergency personnel arrive.

K. Reporting Of Radiation Incidents

1. IT IS THE RESPONSIBILITY OF THE SUB-LICENSEE to report all accidents incidents involving radioactive materials or radiation producing equipment in his/her approved facilities to the **RSO**, by telephone, as soon as practicable. In addition, he/she must also report all incidents involving his/her radioactive materials or radiation producing equipment that may occur outside his/her approved facilities.
2. The sub-licensee initiates this report (in writing) by completing the standard report form ("Report of Accidents Involving ionizing Radiation" Form RS-29) and filing it with the **RSO** as soon as possible. IN NO CASE should the delay exceed one work day. If any

required signatories are absent, their designees should sign in their absence. Any questions on the proper completion of this form should be directed to the **RSO**.

L. Decontamination Procedures - There are many different methods of decontamination depending on the isotope and activity involved, items or material contaminated, and other influencing circumstances. One must also consider the amount of waste to be generated in decontamination and whether the decontamination is cost effective.

1. Preoperational Decontamination Procedure

- **a.** Contact the **RSO**.
- **b.** Plan the decontamination operation thoroughly and obtain adequate supplies.
- **c.** Provide adequate protection for all personnel involved in the decontamination process. If necessary be prepared to allow for replacement personnel.
- **d.** Provide for storage of <u>all</u> radioactive wastes and decontamination supplies.

2. Operational Decontamination Procedure

- **a.** Always work toward center of contaminated area.
- **b.** Monitor frequently.
- **c.** Cover clean areas to avoid recontaminating the area.
- **d.** Monitor all personnel involved before allowing them to proceed to clean areas or leave the laboratory.

3. Post-Operational Decontamination Procedure

- **a.** Monitor all cleaning supplies and equipment before release.
- **b.** Use proper disposal procedures for all radioactive wastes.

4. General Procedures for Handling Minor Spills

- **a.** Put on extra gloves and protective clothing to prevent unneeded personnel contamination.
- **b.** Monitor all persons first to ensure he/she is not contaminated as a result of the accident.
- **c.** Drop absorbent paper, cloth or other suitable containment material on or around spill to limit the spread of contamination.
- **d.** Monitor and mark off the contaminated area. **<u>DO</u> <u>NOT</u>** let any person out of the laboratory without being monitored. It is a good idea to assign monitoring responsibilities to one person.
- **e.** Using normal cleaning agents, proceed from the outermost edges of the contained area inwards, systematically reducing the contaminated area.
- **f.** Keep cleaning supplies to a minimum needed to do the job and place into sealed bags after use.
- **g.** Put all contaminated objects and material into proper waste containers. If the above method does not work after 3 or 4 tries, contact the **RSO** before proceeding to more extreme methods of decontamination.

5. Personnel contamination

a. Identify areas(s) with a survey meter (swipe test of area may be needed if very low energy beta emitters are involved). **DO NOT** use decontamination methods, which will spread localized material or increase penetration of the radioactive material into the body (e.g. by abrasion of the skin).

b. Decontamination of an open wound shall only be accomplished by a physician.

CAUTION - AVOID THE USE OF HIGHLY ALKALINE SOAPS (may result in the fixation of radioactive material) or ORGANIC SOLVENTS (may increase skin penetration of radioactive material).

c. The following procedure should be used on intact skin:

(1) Wet hands and apply detergent.
(2) Work up good lather, keep lather wet.
(3) Work lather into the contaminated area by rubbing gently for at least 3 minutes. Apply fresh water frequently.
(4) Rinse thoroughly using lukewarm water, limiting water to contaminated area.
(5) Repeat above procedures several times, if necessary **gently** scrub residually contaminated areas with a **VERY SOFT** bristle brush.
(6) Additional decontamination methods can be obtained from the **RSO**, however **DO NOT** proceed with more severe methods until consultation with the **RSO**.

NOTE - If contamination is at a wound site, medical personnel should monitor or perform the cleansing of the wound area. REMEMBER - If your initial efforts at decontamination DO NOT produce encouraging results; cover the contaminated area and seek the proper assistance.

EMERGENCY INFORMATION

TTU RADIATION SAFETY OFFICE 742-3876

RSO (HOME).....632-0915

DIRECTOR, ENV. HEALTH & SAFETY (HOME).....785-5934

CHAIRMAN, RADIATION SAFETY COMMITTEE (HOME) 828-5787

TTU FIRE MARSHAL (HOME) 799-1701

TTU POLICE SERVICES.....742-3931

CAMPUS EMERGENCY ..... DIAL 9911

TEXAS BUREAU OF RADIATION CONTROL (BRC) .....(512) 835-7000

IF TTU RADIATION EMERGENCY PERSONNEL CANNOT BE CONTACTED CALL:

BRC 24 HOUR EMERGENCY PHONE NUMBER.....(512) 458-7460

BRC-REGION II RADIATION CONTROL (CANYON) ..... (806) 655-7151

END OF SECTION V

SECTION VI – RADIATION SURVEYS

A. Guidelines For Surveys of Radiation Levels

General Information- There are several types of radiation detection equipment for monitoring areas that are subjected to radioactive contamination, monitoring radiation producing equipment, and sealed sources of radioactive material. Each type is best suited for a particular application and should be used in conjunction with one another. The most common type is the G-M survey-rate meter, which is used for monitoring low-level radiation areas (most common in radioactive material labs). For high-level areas, accelerators, analytical x-ray instruments, etc. an ion-chamber type (i.e. Cutie Pie) is recommended over the GM survey rate meter type. It has two basic , yet important advantages: higher radiation levels can be measured (up to 5,000 mR/hr or more); also, it will not saturate in high radiation fields. That is GM tube type meter may saturate and read zero - when exposed to high radiation levels. Therefore, personnel could be subjected to dangerously high radiation levels in belief that no radiation hazard existed.

> **Note:** Survey rate-meters are required in all installations using radioactive material or Radiation Producing Equipment.

1. **Survey Information –** Because a direct radiation survey is time consuming if properly done; a preliminary evaluation should be performed. A properly calibrated survey meter (G-M or scintillator as appropriate) with audible signal should be used. Be sure the survey meter has a range capable reading the radiation fields that are most commonly encountered in that particular area. In other words make sure the meter will not zero out as described above.

2. **Performing a Survey**

   a. First find a radiation free area or make sure that all radiation producing equipment is turned off or not generating x-rays; then with the meter on its lowest scale take a general or average background reading (usually 0.01 - 0.05 mR/hr or 0 - 150 cpm in clean areas); this reading should be recorded on the survey map or in the log book.

   b. While listening for changes in the audible output signal the individual conducting the survey will perform a thorough scan of all areas within the area covered by the survey map and/or equipment involved. Any area indicating an average reading of more than 3 times the recorded average background reading will be marked on the survey map. If there are no areas where direct radiation levels exceed 3 times background, direct radiation levels may be recorded as "0.1 mR/hr" unless this level (0.1) exceeds recorded background. Then the actual levels should be recorded.

   c. The surveyor will immediately re-measure areas where readings were greater than 3 times recorded background to identify excessive radiation levels. This survey should be conducted with an ion-chamber type instrument; the reading properly recorded on the map or in the log book (i.e. mR/hr, cpm, etc.).

NOTE - Survey meters are required to be calibrated annually. Contact the **RSO** if your meter has not been calibrated within the past year. There should be a calibration sticker attached to the meter indicating the last calibration and the due date for the next one.

3. **Results/Reporting –** Record all results in the proper units (mR/hr and/or cpm) in your log book or on the survey map. If surveys show areas that are greater than 2 mR/hr for radioactive material laboratories contact the **RSO**. For radiation producing equipment surveys that indicate areas more than 3 times the normal recorded reading.

   NOTE - In general it is very hard to put exact numbers on excessive levels (readings) since much of the older analytical x-ray equipment will have radiation levels that are relatively high compared to most radioactive material use areas or the newer closed beam analytical x-ray equipment. However, if there is ever a question concerning the radiation levels around a particular instrument or area call the **RSO** immediately.

B. Surface Contamination Surveys (i.e. Smear/Swipe Survey)

1. **General Information** - the routine monitoring for radioactive contamination in radioactive material laboratories is a necessary and required part of the radiation safety program at TTU. Failure to control surface contamination may cause unnecessary internal or external radiation exposure to individuals, costly decontamination of equipment, laboratories or buildings and/or the loss of equipment, laboratories or building, if gross contamination were found and could not be decontaminated to acceptable levels.

   Generally, the primary concern is to avoid internal exposure resulting from the intake of loose radioactive material via inhalation, ingestion, or skin absorption. However, external radiation levels from radioactive contamination may at times be hazardous. Another major concern is limiting contamination to areas of equipment where it can be controlled or properly disposed and/or maintaining levels of contamination at/or below acceptable levels listed in **TAC §289.202(ggg)(6).**

   a. **Removable Contamination** - Is that fraction of contamination present on a surface that can be transferred to a smear test paper by rubbing with moderate pressure.
   b. **Fixed Contamination** - Is generally defined as radioactivity remaining on a surface after repeated decontamination efforts have failed to significantly reduce the contamination level.
   c. **Equipment** - Instrument used in surface contamination surveys should be sufficiently sensitive to detect the nuclides being monitored. Also uniform methods of collecting and analyzing these smears should be used over extended periods of time in order to evaluate trends.

d. The equipment used to count (analyze) the smear samples shall be properly calibrated, maintained, and shall be capable of detecting the radiation from the smears.

EXAMPLE - Smears of ^{3}H, ^{14}C, ^{35}S, or other beta emitters should be analyzed with a liquid scintillation counter or internal proportional counters.

e. **Method** - The methodology in conducting smear tests varies greatly from institution to institution, from researcher to researcher, and from individual to individual. Keeping this in mind the following is a general guideline for smear testing.

(1) The purpose is to find ANY contamination that might be present. Continual, aggressive monitoring will almost always give the surveyor confidence in certifying his/her area is CLEAN.

(2) Prepare for the survey by; looking over previous survey records; find out what radiation sources are in the lab; identify problem areas (fume hoods, radiological sinks) ; identify previous problem areas.

(3) The next step in the smear process is to obtain a map (diagram) of the area or sketch it out on a piece of paper.

NOTE -This should only have to be done on a first survey only: after that a good diagram should be kept on file, unless the physical layout of the area significantly changes. Current copies of most laboratory diagrams are available from the **RSO**.

(4) When needed the diagram may be replaced or written on to include a detailed list of specialized items or equipment surveyed. In addition to this the surveyor might find it beneficial to specify key areas on the diagram that are smear tested at each survey.

(5) Before beginning the surveyor should prepare him/herself with the proper equipment to conduct a routine survey: smear paper (Whatman 4.25 cm #1 or equivalent) , rubber gloves, diagram, writing instruments, vials or some other apparatus to prevent cross-contamination of the smears.

(6) CAUTION - The surveyor should mentally and physically go about his/her survey in a method that would prevent the unnecessary spread of contamination. What this means is to start in the "coldest" area (least area of probable contamination) and progressively proceed to areas of greater probable contamination.

(7) If the surveyor is conducting a survey in his/her own area or in another the following questions might be asked of him/herself or the lab workers to get a better idea of where to smear and how many smears should be taken:

(a) What isotopes have been used since the last survey?
(b) Where are/were they used?
(c) Where are they stored?
(d) Where is the waste stored?
(e) Have there been any contamination problems in surveys conducted by the lab personnel?

(8) The surveyor then decides on a representative sampling of the area (i.e. where and how many) usually based on three areas of input: individual idiosyncrasies, materials and processing, and traffic patterns.

(9) Idiosyncrasies - Look for information regarding habits and misplaced items around the lab; feet on the desks, misplaced books and equipment, etc.

(10) Materials - Look for changes in work areas, changes in previously recorded storage location, or waste storage areas, non-radioactive use of storage containers, etc.

(11) Traffic - Look for high traffic areas. Particularly worn areas on the floor, high use equipment, floors near a desk, phone, sink, hood, etc, etc.

(12) Where to Smear; Where Not to Smear - Probably the biggest problem associated with smear surveys is "what is proper to smear and what is not". Many manuals and institutions are very vague about this, but few good points to remember are:

(a) Areas of known contamination need not be smeared. This does not mean anything can be treated as contaminated. It is for certain hood trays, absorbent paper, or other equipment which is frequently used for radioactive material work and which is CLEARLY marked with standard caution signs, and stickers.

NOTE - These items SHALL be decontaminated or disposed of after the experiment or use and BEFORE deactivation or termination of the sub-license.

(b) Some DO'S and DON'TS

- DON'T smear the inside of a working or holding tray.
- DO smear: the counter around the tray, the floor around and/or below the tray, and the walls around the tray.
- DON'T smear used vials or labware containing radioactive material.
- DO smear: surfaces where the vials were placed, rings on surfaces where the containers may have been located.
- DON'T smear the inside of rad-waste containers.
- DO smear: the exterior of the container and any suspicious looking streaks of areas, the floor or countertop around the container, and walls or vertical areas near the container.

(c) Other Items and Special Areas to Pay Attention to:

- Telephone
- Door knobs
- Refrigerators/freezers (inside; shelves, bottom, shelf guards. outside; flat tops, suspicious streaks, handles, locks).
- Base cabinet doors (inside and outside)
- Drawers - inside (where contaminated equipment may have been placed).

- Instruments - knobs, on-off switches, keyboards, etc.
- Floors - entrances, near hoods, refrigerators/freezers, sinks, work stations, worn areas.
- Any area where equipment has been moved from -walls, floors, etc.

f. Taking the Smear - Here is the second problem associated with the smear surveys "What constitutes a smear or swipe?". Fundamentally the surveyor applies (using rubber gloves) moderate pressure to the back of the smear and rubs it over the surface to be surveyed (some surveyors like to use a No. 8 or No. 10 rubber stopper) usually no more than 100 cm^2 or 16 square inches. Most institutions allow and "S" motion of about 12-16 inches on a large open surfaces (eg, walls, floors, countertops, etc). The smear is then placed either in separate vials or something to prevent cross-contamination. It is a good idea to change gloves periodically to prevent cross-contamination from the gloves.

g. The smears are then transported to a counter capable of monitoring the radiation surveyed.

2. Frequency of Surveys

a. General Information- The frequency of surveys depends on the nature, quantity, and use of radioactive material as well as equipment and procedures that are designed to protect the workers from unnecessary exposure.

Routine surveys are necessary to control the containment of radioactive material within specified areas and to ensure the reliability of protective equipment, containers and procedures. For any process involving any type of "loose" radioactive material (i.e. gas, liquid, finely divided form) the surveys shall be designed to monitor the containment and control of radioactive material involved.

(1) Frequency - Surveys should be performed in direct proportion to isotope use.
(2) EXAMPLE - If a person uses radioactive material once or twice a month then 1 or 2 surveys a month should be conducted.
(3) If there is no use of radioactive material, a survey is still required at least ONCE a month, to ensure containment control. Surveys shall be continual as long as there is radioactive material or rad-waste in the laboratory.

3. Records of Surveys -

a. Records shall be maintained in logbooks or on special forms as long as they are clear, legible, understandable, and reviewed by authorized individuals.

b. Maintain the following information in the logbook or on a special form:

- date of survey
- counts per minute
- diagram of laboratory
- smear location
- machine copy of results
- dpm or standard reference source count

c. Each batch of survey samples should include a standard reference source and a background sample count.

d. Refer to **TAC §289.202(ggg)(6)** for contamination action levels and release limits.

SECTION VII – FORMS AND RECORDS

A. Radioactive Material Use Forms
B. Radiation Producing Equipment Forms
C. Additional Forms

APPENDICES

RADIATION SAFETY INFORMATION

AND RESOURCES

APPENDIX A – REFERENCE INFORMATION

A.1. Glossary of Terms

Introduction - This section lists information pertinent to radiation safety and is considered to be a part of this manual. The definitions in this glossary will not cover every term associated with radiation but does cover a majority of the terms. If a term should be encountered in your work with radiation and is not in this glossary, consult your supervisor or call the TTU Department of Environmental Health and Safety.

Radiation Terms

ABSORBED DOSE: The amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material.

ABSORPTION: The phenomenon by which radiation imparts some or all of its energy to any material through which it passes.

ACTIVITY: The number of nuclear disintegrations occurring in a given quantity of material per unit time.

ADMINISTRATIVE PENALTIES: Means a monetary penalty assessed by the Bureau of Radiation Control for violations of the **TRCR** (**TAC**) and/or local policies and procedures, to deter future violations and to assure continued compliance.

AIRBORNE RADIOACTIVE MATERIAL: Means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases.

ALPHA PARTICLE: A strongly ionizing particle emitted from the nucleus during radioactive decay having a mass and charge equal in magnitude to a helium nucleus.

ALPHA RAY: A stream of fast moving helium nuclei (alpha particles), a strongly ionizing and weakly penetrating radiation.

ANALYTICAL X-RAY EQUIPMENT: Means x-ray equipment used for x-ray diffraction, florescence, or spectroscopy.

ANALYTICAL X-RAY SYSTEM: Means a group of local and remote components utilizing x-rays to determine the elemental composition or to examine the microstructure of materials. Local components include those that are struck by x-rays such as radiation source housing, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors, and shielding. Remote components include power supplies, transformers, amplifiers, readout devices, and control panels.

ANNIHILATION: An interaction between a positive and negative electron; their energy, including rest energy, being converted into electromagnetic radiation (annihilation radiation).

ANNUAL LIMIT ON INTAKE (ALI): Derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

ATOM: Smallest particle of an element which is capable of entering into a chemical reaction.

AUTORADIOGRAPH: Record of radiation from radioactive material in an object made by placing the object in close proximity to a photographic emulsion.

BACKGROUND RADIATION: Ionizing radiation arising from radioactive material other than the source directly under consideration.

BETA PARTICLE: Charged particle emitted from the nucleus of an atom, having a mass and charge equal in magnitude to an electron.

BETA RAY: A stream of high speed electrons or positrons of nuclear origin. Higher penetration but less ionization than alpha rays.

BRC: Means Bureau of Radiation Control a division of the Texas Department of Health.

BREMSSTRAHLUNG: Electromagnetic (x-ray) radiation associated with deceleration of charged particles passing through matter.

COMMITTED DOSE EQUIVALENT (HT,50): 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 (HE, 50): Sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues (HE, 50 = SwTHT,50).

CONTAMINATION, RADIOACTIVE: The deposit of radioactive material in any place where it is not desired, and particularly where its presence can cause harm.

CARRIER FREE: An adjective applied to one or more radionuclides in minute quantity, essentially undiluted with a stable carrier.

CFR: Means Code of Federal Regulations.

CRITICAL ORGAN: That organ or tissue, the irradiation of which will result in the greatest hazard to the health or the individual or his descendents.

DECAY, RADIOACTIVE: Disintegrations of the nucleus of an unstable isotope by the spontaneous emission of charged particles and/or photons.

DEEP DOSE EQUIVALENT (Hd): Applies to external whole body exposure, is the dose equivalent at a tissue dept of 1 cm (1000 mg/cm^2.) but internal organ(s) still considered to be irradiated.

DERIVED AIR CONCENTRATION (DAC): Concentration of a given radionuclide in air which, if breathed by the reference man for working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI.

DOSE: A general term denoting the quantity of radiation or energy absorbed in a specified mass. For special purposes it must be appropriately qualified, e.g. absorbed dose.

DOSE EQUIVALENT: A quantity used in radiation protection expressing all radiation on a common scale for calculating the effective absorbed dose. The unit for the dose equivalent is the rem, which is numerically equal to the absorbed does in rads multiplied by a quality factor.

ELECTRON: Negatively charged elementary particle which is a constituent of every neutral atom.

ELECTRON VOLT: A unit of energy equivalent to the amount of energy gained by an electron in passing through a potential of 1 volt.

EXPOSURE: A measure of the ionizing that is produced in air by x or gamma rays. It is the sum of the electrical charges on all the ions of one sign produced in air when all electrons liberated by photons in a volume element of air car completely stopped in air, divided by the mass of air in the volume element.

Note: The unit for exposure is the roentgen.

FAIL SAFE CHARACTERISTICS: Means a design feature which causes beam port shutters to close, or otherwise prevents emergence of the primary beam, upon failure of a safety or warning device.

GAMMA RAY: Very penetrating electromagnetic radiation of nuclear origin. Except for origin, identical to x-rays.

GEIGER-MUELLER (G-M) COUNTER: Highly sensitive gas-filled detector and associated circuitry used for radiation detection and measurement.

GENETIC EFFECT OF RADIATION: Inheritable changes, chiefly mutations, produced by the absorption of ionizing radiation. On the basis of present knowledge these effects are purely additive, and there is no recovery.

HALF-LIFE BIOLOGICAL: The time required for the body to eliminate one-half of an administered dose of any substance by the regular processes of elimination. This time is approximately the same for the stable and radionuclides of a particular element.

HALF-LIFE EFFECTIVE: Time required for a radionuclide in a system to be diminished 50 percent as a result of the combined actin of radioactive decay and biological elimination.

HALF-LIFE RADIOACTIVE: Time required for a radioactive substance to lose 50 percent of its activity by decay. Each radionuclide has its own unique half-life.

HALF VALUE LAYER (half thickness): The thickness of any specified material necessary to reduce the intensity of an x-ray or gamma ray bean to one-half it original value.

INSPECTION: Means on examination and/or observation including but not limited to records, tests, surveys, safety check, and monitoring to determine compliance with state and local rules, regulations and requirements.

INVERSE SQUARE LAW: The intensity of radiation at any distance from a point source varies inversely as the square of the distance.

ION: Atomic particle, atom, or chemical radical bearing an electrical charge, either negative or positive.

IONIZATION: The process by which a neutral atom or molecule acquires either a positive or negative charge.

IONIZATION CHAMBER: An instrument designed to measure the quantity of ionizing radiation in terms of the charge of electricity associated with ions produced within a defined volume.

IONIZATION, SPECIFIC: The number of ion pairs per unit length of path of ionizing radiation in a medium.

IONIZING RADIATION: Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly in it passage through matter.

ISOTOPES: Nuclides having the same number of protons in their nuclei, and hence having the same atomic number but differing in the number of neutrons, and therefore in the mass number.

LABELED COMPOUND: A compound consisting, in part, of labeled molecules.

MAXIMUM PERMISSIBLE DOSE: Maximum dose of radiation which may be received by persons working with ionizing radiation, which will produce no detectable damage over the normal life span.

MILLIROENTGEN (mR): A submultiple of the roentgen equal of one-thousandth of a roentgen.

NEUTRON: Elementary particle with a mass approximately the same as that of a hydrogen atom and electrically neutral. It has a half-life in minutes and decays in free state into a proton and an electron.

NORMAL OPERATING PROCEDURES: Operating procedure for conditions suitable for analytical purposes with shielding and barriers in place. These do not include maintenance but do include routine alignment procedures. Routine and emergency radiation safety considerations are part of these procedures (reference **TRCR 32.2(d)**).

NUCLIDE: A species of atom characterized by its mass number, atomic number, and energy state of its nucleus, provided that the atom is capable for a measurable time.

OPEN BEAM CONFIGURATION: An analytical X-ray system in which an individual could accidentally place some part of his body into the primary beam path during normal operation.

PRIMARY BEAM: Ionizing radiation which passes through an aperture of the source housing by a direct path from the x-ray tube located in the radiation source housing.

RADIATION: 1. The emission and propagation of energy through space or through a material medium in the form of waves. 2. The energy propagated through a material medium as waves; for example, energy in the form of elastic waves. Such as Hertzian, infrared, visible (light), etc. 3. By extension, corpuscular emissions, such as alpha and beta radiation, or ray of mixed or unknown type, as cosmic radiation.

RADIOLOGICAL SURVEY: Evaluation of the radiation hazards incident to the production, use or existence of radioactive materials or other sources of radiation under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible change sin materials or equipment.

RADIONUCLIDE: A nuclide with an unstable ratio of neutrons to protons placing the nucleus in a state of stress. In any attempt to reorganize to a more stable state, it may undergo various types of rearrangement that involve the release of radiation.

RADIOTOXICITY: Term referring to the potential of an isotope to cause damage to living tissue by absorption of energy from the disintegration of the radioactive material introduced into the body.

RAM: means radioactive material.

RELATIVE BIOLOGICAL EFFECTIVENESS: For a particular living organism, the ratio of absorbed dose of a reference radiation that produces a specified biological effect to the absorbed dose of the radiation of interest that produces the same biological effect.

REM: The special unit of dose equivalent. The dose equivalent in rems in numerically equal to the absorbed does in rads multiplied by the quality factor, distribution factor, and any other necessary modifying factors.

RSC: means Radiation Safety Committee.

ROENTGEN: The quantity of x or gamma radiation such that the associated corpuscular emission per 0.001293 grams of dry air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign. The roentgen is the special unit of exposure.

RSO: means Radiation Safety Officer of TTU.

SHIELDING MATERIAL: Any material which is used to absorb radiation and thus effectively reduce the intensity of radiation, and in some cases eliminate it.

SMEAR (smear or swipe test): A procedure in which a swab, e.g., a circle of filter paper, is rubbed on a surface and it radioactivity measured to determine if the surface is contaminated with loose radioactive material.

SPECIFIC ACTIVITY: Total radioactivity of a given nuclide per gram of compound, element or radioactive nuclide.
TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE): Sum of the deep dose equivalent (for external exposures) and CEDE (for internal exposures).

TRACER, ISOTOPIC: The isotope or non-natural mixture of isotopes of an element which may be incorporated into a sample to make possible observation to the course of that element, alone or in combination, through a chemical, biological, or physical process. The observations may be made by measurement of radioactivity or of isotopic abundance.

THERMOLUMINESCENT DOSIMETER (TLD): A dosimeter made of certain crystalline material which is capable of both storing a fraction of absorbed ionizing radiation and releasing this energy in the form of visible photons when heated. The amount of light released can be used as a measure of radiation exposure to these crystals.

X-RAYS: Penetrating electromagnetic radiation having wavelength shorter than those of visible light they are usually produces by bombarding a metallic target with fast electrons in a high vacuum. In nuclear reactions it is customary to refer to photons originating in the nucleus as gamma rays, and those originating in the extranuclear part of the atom as x-rays.

A.2. INDEX OF ABBREVIATIONS AND ACRONYMS

ALARA	As Low As Reasonably Achievable
BRC	Bureau of Radiation Control
CFR	Code of Federal Regulations
DOH	Department of Health
DOT	US Department of Transportation
FDA	Federal Drug Administration
FRC	Federal Radiation Council
GC	Gas Chromatograph .
ICRP	International Commission on Radiation Protection
MPD	Maximum Permissible Dose
NCRP	National Council on Radiation Protection and Measurements
NRC	Nuclear Regulatory Commission
OP	Operating Procedure
PO	Purchase Order
RAM	Radioactive Material
RIA	Radioimmunoassay
RPG	Radiation Protection Guide
RSC	Radiation Safety Committee
RSO	Radiation Safety Officer
TDH	Texas Department of Health
TLD	Thermoluminescent Dosimetry
TRCR	Texas Regulations for Control of Radiation
TTU	Texas Tech University

A.3. List Of Symbols for Radiation Units and Terms

Measurements /Units

Ci	Curie
m	milli (one thousandth)
u	micron (one millionth)
k	kilo (thousand)
R	roentgen
rem	radiation equivalent man
dpm	disintegrations per minute
dps	disintegrations per second
cpm	counts per minute
MeV	Million electron volt
LET	Linear Energy Transfer
QF	Quality Factor

Appendix B - Texas Regulations for Control of Radiation References

Introduction - The following section will briefly describe specific parts of the **Texas Regulations for Control of Radiation (TRCR) and the Texas Regulations for Control of Laser Radiation Hazards (TRCLRH).** TTU is subject to the rules of the **TRCR, TRCLRH,** and other state, federal, and local regulations when using radiation. These specific parts have been extracted because of overall benefit to all radiation users at TTU. More specific information can be obtained from the Radiation Safety Office

1. **25 TAC §289.201 (TRCR Part 11) - General Provisions,** Texas Regulations for Control of Radiation: contains general information concerning recordkeeping, testing of sealed sources, violation information, and transport grouping of radionuclides.

2. **TRCR Part 13** contains rules and regulations pertaining to amending licenses, annulment of licenses, administrative penalties (i.e., fines), impoundment of sources of radiation, etc.

3. **25 TAC §289.202 (TRCR Part 21), Standards for Protection Against Radiation** - establishes standards for protection against ionizing radiation hazards. It is the purpose of the rules in this part to control the possession, use, and transfer of sources of radiation by any licensee so as to ensure that the dose to any individual does not exceed the standards established in this part. Areas covered include exposure limits, concentration of radioactive material in effluents, personnel monitoring, storage, disposal, records, limits of concentrations, etc.. This part is the basis for **ALARA,** "As Low As Reasonably Achievable", which means that each user should make every effort to keep exposures and releases as low as reasonably achievable.

4. **25 TAC §289.203 (TRCR Part 22), Notices, Instructions, and Reports to Workers; Inspections** - establishes requirements for notices, instructions, and reports by licensees or registrants to individual engaged in work under a license or registration, and options available to such individuals in connection with the State Bureau of Radiation Control (BRC) inspections regarding radiological conditions. Areas of particular interest are requirements for Posting of Notices, Instructions to Workers, Requests by Workers for Inspections, etc.

5. **TRCR Part 34, Radiation Safety Requirements for Analytical X-Ray Equipment** - This part provides special requirements for analytical X-ray equipment. Areas covered are equipment requirements, area requirements, operating requirements, and personnel requirements.

6. **PARTS 50, 60, & 70 - TEXAS REGULATIONS FOR THE CONTROL OF LASER RADIATION HAZARDS** - The objective of these regulations is to provide guidance for safe use of laser products and laser installations. Areas of particular interest include supervision, controls, safety requirements, regulations, and requirements for safe operation, signs, surveys, records, and registrations.

Appendix C - Instrument Calibration Procedures

(12/01/99)

Note:
Only persons specifically authorized by the RSO may participate in the procedures set out in this attachment

APPENDIX C - INSTRUMENT CALIBRATION PROCEDURES

General Procedure for Calibration of Radiation Detection and Measurement Instruments

1. **Alpha Measuring Instruments:** will be calibrated annually by using a standard alpha source.

2. **Beta Measuring Instruments:** will be calibrated annually by using a standard beta source.

3. **Ionization Chamber Instruments:** will be calibrated annually by an authorized instrument service company or by the procedure in Part B.

4. **Well Counters:** will be calibrated annually by an authorized instrument service company.

5. **MCA's:** will be calibrated, using standard sources, each time they are turned on for operation and as necessary during analytical procedures.

6. **GM Radiation Survey Instruments:** will be calibrated annually using the procedure in Part B of this procedure or by an authorized instrument service company

Periodic Calibration of Instruments

1. **Purpose:** This procedure will be used by TTU to perform its own annual radiation survey instrument calibrations for GM and, in some cases, ionization chamber instruments. *In the event that TTU cannot perform the calibration of a needed instrument, an authorized service company will be used.*

2. **Scope:** Each instrument will be calibrated to verify that it correctly measures the intensity of a radiation field (mR/hr). The procedure involves using a Ludlum Pulser to adjust the electronics of the instrument and then placing the instrument in a radiation field of known intensity and making necessary adjustments or calculations to verify the accuracy or determine correction factors.

3. **Objective:** To verify that each instrument is capable of measuring radiation levels over its multiple ranges to within plus or minus 20 percent of the true radiation level for the appropriate energies of the radiation.

4. **Method:** A known radiation field for the calibration procedure is provided through the use of a known source in a calibrator/shield. The beam calibrator is a manually operated device which incorporates a Cesium-137 source with an initial activity of 100 millicuries. The shield of the calibrator provides for full shielding in all directions at all times except when the unit is in the "ON" position. In the "ON" position, a radiation beam is emitted out of the port.

5. **Applicability:** This procedure applies only to GM and ionization chamber type instruments

6. Precautions and Safety:

a. Personnel Monitoring: *The person(s) performing the calibration procedures MUST wear his/her assigned personnel monitoring device and pocket dosimeter.*

b. Area Access: ONLY persons properly trained in instrument calibration procedures AND authorized by the RSO may conduct instrument calibrations.

c. Area Control: The area(s) where the calibrations are to be performed will cleared of unauthorized/non-essential persons prior to initiating calibration procedures. "Caution - Radiation Area" signs will be posted at the entrance(s) to the area. Should any unauthorized/unmonitored person enter the area, the calibrator will immediately be turned to the OFF position.

d. Emergencies and Malfunctions:

(1) Calibrator Malfunction: if the ON/OFF shutter mechanism fails such that the beam cannot be shut off, immediately clear and secure the area and notify the RSO. DO NOT leave the area unattended!

(2) Improper Calibrator Operation: should the operation of the source rod become difficult, the calibrator shall be removed from service and returned to the manufacturer for repair.

7. Instrument Inspection: A thorough inspection of the instrument must be performed prior to the calibration procedure, as follows:

a. Visual Inspection: Visually check the outer meter face, adjustment knob, handle and meter case. Certain components, when damaged (such as the meter face, needle and adjustment knob), may affect the ability to calibrate.

b. Battery Condition Check: Inspect the batteries for damage and test for charge. Replace if necessary. Weak batteries can cause erratic behavior.

c. Electrical Inspection: Remove the case and visually inspect the electrical/electronic components. Inspect the internal probe, if present. If any component appears to be burned, broken, or loose, or there appears to be internal corrosion or moisture, do not proceed with calibration. Minor problems may be correctable, such as re-soldering a wire or removing corrosion or moisture. If repairs are satisfactorily performed, replace the cover and proceed with calibration. Otherwise, the instrument must be sent to an instrument repair service.

d. Electronics Test: Perform the electronics test using the Pulser as stated in the applicable Ludlum Instruction Manual.

e. Mechanical Inspection: Inspect and/or test all mechanical hardware, such as nuts, screws, etc., to ensure that they are secure. Check the retaining screw that holds the selector knob on, the retaining screw for the handle, screws that hold the circuit board to the meter body, screws on the meter movement, etc. If necessary, all loose hardware must be tightened. Check the proper operation of switches to assure that they "lock in" on the selected positions.

f. Probe and Connecting Cable Inspection: Inspect the cable and connectors for signs of damage or wear. Kinks in the cable may cause erratic behavior. The connectors must be of tight fit and the pins intact and firm. The connectors should attach to the instrument and probe connections firmly. Repair or replace the cable before proceeding with calibration.

8. Instrument Calibration (GM and ionization chamber instruments):

Note: *Only persons authorized by the RSO shall be allowed to calibrate radiation survey instruments.*

a. Prepare Calibration Record/Certificate: Prepare a calibration record/certificate for each instrument to be calibrated.

b. Determine Calibration Points:

(1) Calculate and record the current source strength.

(2) Determine the points (distances from calibrator) at which the instrument (probe) must be placed to produce the necessary radiation levels which allow calibration at two points on each range. Enter the field intensities on the calibration record(s) for each instrument.

c. Establish Calibration Range: Mark the calibration range for the determined points (distances).

d. Calibrate at Each Point:

(1) Place the instrument at the desired point to checked

(2) Unlock the device and expose the source.

(3) Observe the reading on the instrument face at each predetermined point.

(4) If the instrument reading does not agree with the field intensity (within plus or minus 20%), the calibration potentiometer for that range must be adjusted until the instrument indicates the correct response. Caution: a small a mount of adjustment produces a relatively large change in the instrument reading.

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> **Note: .....** *For instruments that have only one calibration potentiometer, all ranges must be checked before adjusting the potentiometer. The potentiometer affects all ranges.*

(5) Once the adjustments have been made, place the instrument back at the same location and verify the reading.

(6) Repeat steps 6.d.1 through 6.d.5 for each point to be calibrated. It may be necessary to use attenuation blocks to obtain the lower range readings.

e. Turn Calibrator Off: Return the source to the "OFF" position. Lock the calibrator.

9. Calibration Records:

a. Calibration Record and Certificate: For each instrument calibrated, complete the following sections of the instrument calibration record (**Attachment E.2 – Certificate of Calibration, Form RS-32**):

- Sublicensee name and identifying information
- Instrument/detector manufacturer and information
- Calibration results
- Calibration method information

b. Certification: The person performing the calibration must sign the "Calibrated by" space and enter the date of calibration. Indicate the next due date based on the calibration interval for the type of use of the instrument.

c. Calibration Sticker: A "calibration sticker", should be placed on the instrument (obscure or remove previous ones) to indicate who calibrated the instrument; authorization (license number); date of calibration; next due date; instrument make, model and serial number; and the identity of the person performing the calibration.

10. Serviceability of Instruments:

a. Successful Calibration: If the instrument was successfully calibrated, submit the completed "Survey Instrument Calibration Certificate" to the RSO for review and filing. Return the instrument to its proper storage location.

b. Unsuccessful Calibration: If unable to calibrate an instrument, or the instrument requires repair, tag it as unusable and needing repair. Submit the instrument with notes of problem(s) to the RSO.

Sample: "SURVEY METER CALIBRATION LABELS" (stickers)

TEXAS TECH UNIVERSITY

MFG_____ Model _____ Ser.#_____

Cal.Date_____ Due Date _____

Cal.Source_____ High Voltage _____

Tube I.D. _____

Cal. By _____ Texas Tech License L01536

TEXAS TECH UNIVERSITY
ENVIRONMENTAL HEALTH AND SAFETY

CERTIFICATE OF CALIBRATION

State of Texas Broad License #L01536

Sublicensee _____ Dept. _____ Account # _____

Instrument Manufacturer _____ Model # _____ Serial # _____

Detector Manufacturer _____ Model # _____ Serial # _____

Last Calibration Date _____ Today's Calibration Date _____ Calibration Due Date _____

☐ Battery ☐ Meter Zeroed ☐ F/S Response ☐ Zero ☐ Reset Audio Meter Face Number _____

Detector Tube Voltage _____ Volts

HV "As Found" Reading _____Volts

Meter HV Adjusted Reading _____Volts

Input Sensitivity _____mVolts

Maximum Reading Per Scale (mR/hr or CPM)	**Calibration Point (mR/hr or CPM)**	**Meter Reading "As Found" (mR/hr or CPM)**	**Meter Reading "After Adjustment" (mR/hr or CPM)**	**% Error**

Method of Calibration:

☐ Cs-137 Source ☐ Model 500 Pulser ☐ .1 ☐ 1 ☐ 10 ☐ 100 ☐ 1000 Ranges Calibrated Electronically

☐ Meter Within ± 10% ☐ Within ± 10 – 20% Tolerance

☐ Meter out of Tolerance > ± 20% ☐ Meter Requires Repair

Comments : _____

Calibrated by : _____ Date: _____