

X-Ray Safety Manual

Texas State University

January 24, 2017

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- RMS-RSF-007, Statement of Training and Experience
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- RMS-RSF-009, Radiation Safety Evaluation (Radiation-Producing Machines)
- RMS-RSF-014, Analytical X-Ray Operator Qualifications

PREFACE

X-RAY SAFETY is the responsibility of all faculty, staff, and students who are directly or indirectly involved in the use of radiation producing devices.

The Texas State University is certified by the state of Texas to use radiation producing devices in research, development, and instruction. While this means a minimum of controls by the state, it entails the responsibility that we establish and pursue an effective X-Ray Safety Program. It is the purpose of this manual to set out the guidelines of that program.

The use of radiation producing devices in a university, where a large number of people may be unaware of their exposure to radiation hazards, makes strict adherence to procedures established by federal and state authorities of paramount importance. Special efforts to ensure the safety of faculty, staff, students and the general public are essential. The Risk Management & Safety Office has the responsibility for establishing and pursuing an effective Radiation Safety Program for this University.

It is the responsibility of all faculty, staff, and students involved with radiation producing devices work to familiarize themselves with the program outlined in this manual, and to comply with its requirements. Radiation safety depends on a continuous awareness of potential hazards.

Texas State University Radiation Safety Committee:

Dr. Hector Flores, Dean of Science

Dr. Emilio Carranco, Director Student Health Center

Mr. Frank M. Gonzalez, Director Materials Management

Dr. Carlos J. Gutierrez, Professor - Physics

Mr. Russell Clark, Director Risk Management

Ms. Melissa C. Wells, Grant Specialist

Mr. Jerome Witowski, Supervisor Laboratory Services SHC

Emergency Telephone Numbers

	<u>Ext.</u>	<u>After 5pm</u>
Texas State University RADIATION SAFETY OFFICER		
James Frye	5-4129	5-2805
Risk Management and Safety office Smith House		
Texas State University RISK MANAGEMENT & SAFETY OFFICE		
Risk Management and Safety Office	5-3616	5-2805
Smith House		
Texas State University POLICE DEPARTMENT		
Nueces	5-2805	5-2805
ALL EMERGENCIES		
(Texas State University Police Dispatcher)	911	
UTILITY OUTAGES (Utilities Operations)	5-2350	5-2108
TDH BUREAU OF RADIATION CONTROL		
24-HOUR RADIOLOGICAL EMERGENCY ASSISTANCE.....		512-458-7460
Routine Business		512-834-6688

RADIATION SAFETY MANUAL

SECTION I - MANAGEMENT OF BROAD LICENSE

Introduction

The purpose of this manual is to provide users and non-users of 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 State University are covered. The regulations, policies and procedures set forth in this guide are written to protect Texas State University faculty, staff, students, and visitors against unnecessary and potentially harmful exposure.

A. 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 State University; to protect members of the general public.
2. Method: Texas State University has established this X-Ray Safety Manual (XSM) to provide guidance to faculty, staff, and students when working with x-ray producing devices.
3. Date of Implementation: March 1, 2006, upon approval by the RSC.

B. ALARA Program - General

1. Maximum permissible dose: A sub-licensee may not permit an individual in a restricted area to receive a total effective dose equivalent greater than that permitted under the guidelines of the XSM. There should not be any situations at this university where dose equivalents for external exposures exceed those listed in the XSM.
2. Prohibition of Use by a Minor: There shall be no use of radiation producing equipment by employees under 18 years of age (minors).
3. Pregnant females, or females suspecting pregnancy at Texas State University should consult a doctor. The female, at her discretion, may reduce exposure by voluntarily informing the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman voluntarily withdraws the declaration in writing or is no longer pregnant.

C. Radiation Safety Management

Should any operation involving radiation producing equipment present a threat to the staff or students of the University, or to any member of the general public, the RMS Office has the authority to terminate any such operation until the hazard is removed or mitigated.

D. Radiation Safety Committee

The RSC is composed of a group of administration, faculty, and staff appointed by the University President via the Dean of the College of Sciences to establish policies and regulations governing the use of ionizing radiation. The president has designated the Office of the Vice President for Academic Affairs as the duly authorized representative on matters relating to Radiation Safety.

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See the current Radiation Safety Manual for the duties, membership, committee appointment and responsibilities, and operating procedures of the Radiation Safety Committee.

E. Radiation Safety Officer

The Radiation Safety Officer (RSO) will be a trained professional who is responsible for 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.

See the current Radiation Safety Manual for a complete listing of the duties for the Radiation Safety Officer.

F. Risk Management and Safety Office

Conducts operations and services to support the University radiation safety program.

G. Personnel Monitoring Procedures

This section will give direct information regarding the initiation, requirements, use, and termination of personnel monitoring for radiation exposure at Texas State 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 manual.
Exemptions may only be granted by the Texas Department of State Health Services (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. **ANY** individual not returning a badge of any type will be subject to a dose assessment. 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 radiation producing equipment.
4. Personnel Monitoring Procedures:
 - a. Requests for Dosimetry:
 - (1) If determined by the **RSO** that personal dosimetry will be issued, then personnel working with radiation producing equipment will be required to file a "Dosimetry Request" form RMS-RSF-005.
 - (2) Any person filing a "Dosimetry Request" form RMS-RSF-005 that has worked with radioactive material, radiation producing equipment, or

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- has been previously monitored for radiation exposure at other institution(s) will be asked to fill out the information needed on the "Dosimetry Request" form and the "Previous Exposure History Request" Form RMS-RSF-008 for each employer/institute.
- (3) After receiving the "Dosimetry Request" the RSO will order the dosimetry (if needed). No use of radiation producing equipment will be allowed until confirmation from RSO 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 the University.
 - (3) All individuals are urged to request their permanent exposure history from Texas State University. The Radiation Safety Office will forward permanent exposure histories when requested. Please allow enough time for final badge to be developed, interpreted, and results sent to the University.
- 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 the University 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 be exposed to unnecessary radiation. Specifically, never leave badges lying near 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, contact the RSO with any questions.
 - (10) Reports of exposure to ionizing radiation are kept by the Radiation Safety Officer. Any individual may request (in writing) to review his/her exposure reports at any time. However, the request should indicate the report(s) needed for review.

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SECTION II - SUB-LICENSE PROGRAM SAFETY

Introduction

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

A. Definitions:

1. Certificate of Registration - the specific certificate of registration issued to Texas State University by the Texas Department of State Health Services Radiation Control. This certificate authorizes the university to receive, possess, transfer, and acquire radiation producing equipment and to use such machines at the discretion of the RSC.
2. Sub-license - an authorization issued by the RSC to use radiation producing equipment.
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 radiation producing equipment in their research and educational activities.

NOTE:

The Student Health Center is not required to submit a sub-license application. SHC is a separate entity within Texas State University. The SHC is duly registered with the Department of State Health Services, Radiation Control with a separate Certificate of Registration for radiation producing machines.

B. Sub-License Application Procedures

1. Qualifications for Sub-License
 - a. The applicant must have sufficient training and experience in the use of the radiation-producing equipment requested to ensure that proposed work is conducted and/or supervised in a safe manner.
 - b. The applicant must submit a sublicense application RMS-RSF-002, "Application for Radiation Producing Equipment" form 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 of 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 Texas State X-Ray Safety Course 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 doctoral researchers, etc.) must attend the X-Ray Safety Course.

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- (2) The course will be one hour for workers who can prove by appropriate certificate that prior radiation safety training was completed within the last five years.
 - (3) The course will be two hours for workers with prior experience but who have not had recent training (within the last five years). The worker must challenge and pass a competency exam with a score of at least 70%.
 - (4) For workers who have not had prior training, the training will consist of a combination of classroom and on the job training. A passing score of 70% on a comprehensive exam 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 Texas State University Radiation Safety Officer 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 Texas State University RSC.
 - d. 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 State 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 Officer.
 - 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 there is a change in equipment (X-Ray inventory);
 - (3) If there is a significant change in submitted Operating Procedures.
 - (4) Application forms for license renewal or amendment are available from the Radiation Safety Officer.

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 radiation producing equipment.
Or
2. Notify the RSO as to the responsible individual (another sub-licensee) who will take over supervision of the use of the radiation producing equipment to be

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used. This sub-licensee must be competent in the use and regulations concerning the radiation producing equipment to be used.

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

D. Procedure for Termination of a Sub-license

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

1. The date of termination.
2. The listing of the sub-licensee's authorized laboratories, including storage areas. A diagram of all these areas should accompany this letter of intent.
3. A statement that all radiation producing devices used and/or stored will be disabled or removed. They must be transferred either to the RSO for storage or disposal, or properly transferred to another sub-licensee who is authorized to possess the devices under consideration.
4. Upon receipt of the letter of intent, the RSO will conduct 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 radiation producing equipment, the RSO will make his recommendations to the RSC at its next meeting, which in turn will consider and vote on the request to terminate the sub-license.
6. Upon termination and transfer or disposal of radiation producing equipment, all signs and labels, indicating that the areas was authorized for use of radiation producing equipment, shall be removed. The areas are now considered for unrestricted use.
7. **ON TERMINATION, FURTHER USE OF RADIATION PRODUCING EQUIPMENT BY THE SUB-LICENSEE AND INDIVIDUAL WORKERS OF THAT SUB-LICENSE IS STRICTLY PROHIBITED.**
8. 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 officer or to owners of the equipment at this time.
9. Should a sub-licensee permanently leave Texas State University 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 Texas State University inspection/monitoring program conducted for evaluation of programs operated under sub-licenses.

1. General

A radiation program 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

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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 radiation safety program at Texas State University is periodically evaluated by the Texas State University-RSC and by the Agency for compliance.
 - b. This system of "checks and balances" assures Texas State University and the general public that the radiation program at the University operates safely and efficiently.
2. Frequency of Inspections
- a. The RSO shall make inspections of radiation producing equipment sub-licensees on an annual basis.
 - b. 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 - federal, state, Texas State University, and local.
 - b. The RSO shall make a record of each inspection and keep those on file in the Risk Management and Safety office.
 - c. The RSO will forward a formal report of inspection to each sub-licensee within two weeks of final evaluation of the inspection results, noting corrective action needed.
 - d. Each sub-licensee will revise or correct their 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-licensee, 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-licensee if serious deficiencies are continued.

F. Sub-License/Authorized User Responsibilities

1. Each authorized user has the following obligations:
 - a. Ensuring that the individual user responsibilities are discharged by those under their control and supervising their work;
 - b. Working within the limits of the User's sub-license;
 - c. 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 at required radiation safety courses;

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- d. Furnishing the RSO with information concerning individuals and activities in their areas;
 - e. Ensuring that all surveys and safety checks required for their particular area of interest are carried out and recorded properly;
 - f. 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;
 - g. Complying with the regulations governing the use of radiation producing equipment, as established by the Texas Regulations for Control of Radiation, and Texas State University Policies and Procedures for Radiation Protection;
 - h. Complying with proper procedures for termination of equipment, or termination of sub-license involving the use of radiation producing equipment;
 - i. Complying with the proper procedures for handling radiation incidents;
 - j. Obtaining prior approval, by completing and submitting an application for amendment/renewal form, for the addition/deletion of rooms, radiation producing equipment, or personnel, or for additions or changes to procedures.
2. Responsibilities of Authorized Users -
Authorized users (workers, employees, etc.) faculty, students, other professionals, as well as technicians and other workers engaged in education, laboratory research, and research support activities, which involve actual use and handling of devices producing 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. The sub-licensee shall control the occupational dose to individuals to the following dose limits: Refer to 25 TAC §289.231(m).
 - a. The annual occupational dose shall be the total effective dose equivalent (TEDE) being equal to 5 rems (0.05 sievert); or
 - b. The annual occupational dose to the lens of the eye, to the skin of the whole body, and to the skin of the extremities will not exceed:
 - (1) an lens dose equivalent (LDE) of 15 rems (0.15 sievert), and
 - (2) a shallow dose equivalent (SDE) 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.

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- 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).

SECTION III - RADIATION PRODUCING MACHINE SAFETY PROGRAM

NOTE:

The Student Health Center is not required to adhere to the requirements of this section. SHC is a separate entity within Texas State University. The SHC is duly registered with the Department of State Health Services, Bureau of Radiation Control with a separate Certificate of Registration for radiation producing machines.

A. Registration

1. The Texas Regulations for Control of Radiation require that radiation producing machines be registered with the Bureau of Radiation Control, Texas Department of State Health Services.
2. Registration of proposed devices must be conducted through the Radiation Safety Officer.

B. Personnel Protection

1. Personnel Monitoring: If required, all operating personnel and personnel in the immediate area shall wear a film badge or other personnel monitoring device.
2. Personnel Safety - Personnel specifically responsible for such equipment shall:
 - a) Used or to be used;
 - b) Ensure that all rules and regulations (Texas State University, federal, state and local) have been implemented and are followed; and
 - c) Ensure that all users have attended the Texas State University Radiation Safety Course (given by the RSO) for radiation producing equipment prior to using the radiation producing equipment.
 - d) Complete the required training as per RMS-RSF-014 "Analytical X-Ray Operator Qualifications" and forward completed document to the Radiation Safety Officer.

C. Facilities 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 Officer.
3. Record of Operation: A logbook and a copy of the operating procedures (for that particular instrument or area) shall be attached to each instrument or near the control panel.

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D. Radiation Surveys And Record Keeping Requirements

1. Sub-licensee Requirements:

- (1) Radiation surveys:
 - (a) Radiation surveys will be conducted after every change that might increase radiation exposure hazard.
 - Following any change in initial arrangement, number, or type of local component.
 - Following maintenance requiring disassembly or removal of a local component.
 - During maintenance and alignment if the primary X-Ray beam is present when any local component is disassembled or removed.
 - Visual inspections reveal abnormal conditions.
 - Individual monitoring devices show a significant increase over previous monitoring period.
 - (b) The results of each radiation survey shall be recorded in the log book.
 - (c) 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.

2. 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 Officer.
- (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 Officer.

3. Additional Rules And Requirements

- (1) The RSC, upon recommendation of the RSO, may require additional safety devices or procedures (beyond the minimum TAC

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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.
 - (9) Radiation producing equipment transferred within Texas State University must be coordinated with the RSO.
 - (10) The RSO shall be notified of any instrument taken out of use and placed into storage or prior to disposal.

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SECTION IV - EMERGENCY PROCEDURES

This section outlines basic emergency procedures. An emergency situation or accident can arise from the misuse or abuse of equipment that produces X-Ray radiation or other forms of ionizing radiation. This section is intended to enhance each sub-licensee and worker's ability to react properly to radiation accidents.

Due to the broad scope of possible accidents at Texas State University, 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 accidents is to prepare for them.

A. General Information

A radiation incident at Texas State University should be defined as any unintentional accident or any single exposure or suspected exposure in excess of the exposures as set forth in 25 TAC §289.231(hh).

NOTE

If persons involved in a radiation incident are unsure as to the extent of exposure, those persons shall proceed with the assumption that an overexposure has occurred, unless otherwise noted. Users will report all radiation incidents.

B. Organization and Authority

1. The RSO shall have responsibility for incident investigation.
2. The RSO will promptly report all investigation findings to the RSC and to the Agency [reference 25 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 Texas State University Policies and Procedures Statements. However, 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 easily understood plans for an emergency, and control of an emergency in their respective laboratory.
6. The RSO has the responsibility to see that each radiation sub-licensee/worker knows how to:
 - a. Recognize a radiation 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 obtaining medical attention, if necessary, as soon as practicable.

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C. Fires, Explosions, or Major Emergencies

1. Notify all persons in the area to leave at once.
2. Notify the Texas State University Police Department, the San Marcos Fire Department, EMS, and the RSO as well as other supervisory personnel. Give them the address and the location of the fire.
3. If firefighters arrive before the RSO, caution them that radiation producing devices are present in the area. Be ready to advise them on location, status of system, and any other information that may be needed.
4. The sub-licensee and/or workers will need to be available to evaluate or help evaluate the extent of damage to radiation producing devices.
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 readings of all involved person(s). The RSO will then forward the dosimetry readings for emergency processing.
6. Persons involved in the incident will not be permitted to work with radiation producing devices 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 TDH, RSC, and regulatory agencies.

E. 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: Contact the RSO before proceeding with more severe methods of decontamination.

F. Loss or Theft of Radiation Equipment

1. Any loss or theft of a radiation-producing device, shall be immediately reported to the RSO.
2. The RSO will provide required notification to the Texas Department of State Health Services Radiation Licensing division.
3. The RSO will determine the extent of damage and analyze the recovery plan.

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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.

G. Malfunction of Radiation Producing Equipment

1. Any radiation device (X-Ray, 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 AGENCY within 30 days.

H. Reporting of Radiation Incidents

IT IS THE RESPONSIBILITY OF THE SUB-LICENSEE to report all incidents involving radiation producing equipment in his/her approved facilities to RSO, by telephone, as soon as practicable. In addition, he/she must also report all incidents involving his/her radiation producing equipment that may occur outside his/her approved facilities.

RADIATION SAFETY MANUAL

SECTION V - RADIATION SURVEY GUIDELINES

There are several types of radiation detection equipment for 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 GM survey rate meter, which is used for monitoring low-level radiation areas. For high-level areas an ion chamber type 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 radiation producing equipment.

A. Survey Information -

Because a direct radiation survey is time consuming if properly done; a preliminary evaluation should be performed. A properly calibrated survey meter (GM or 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.

B. Performing a Survey

1. 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); this reading should be recorded on the survey map or in the log book.
2. 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.
3. 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 logbook (i.e. mR/hr, cpm, etc.).

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NOTE

Survey meters require annual calibration. 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 logbook or on the survey map. For radiation producing equipment surveys that indicate areas more than 3 times the normal recorded reading contact the RSO.

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.

Reference Information
Appendix A

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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 lasers or radiation but does cover a majority of the terms. If a term should be encountered in your work with lasers or radiation and is not in this glossary, consult your supervisor or call the Texas State University Risk Management and Safety Office.

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.

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.

AGENCY: Means the Texas Department of State Health Services, Division for Regulatory Services Radiation Control Program.

ANALYTICAL X-RAY EQUIPMENT: Means x-ray equipment used for x-ray diffraction, fluorescence, 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.

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

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

CFR: Means Code of Federal Regulations.

DEEP DOSE EQUIVALENT (H_d): Applies to external whole body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm².) but internal organ(s) still considered to be irradiated.

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 dose in rads multiplied by a quality factor.

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 are 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 that causes beam port shutters to close, or otherwise prevent emergence of the primary beam, upon failure of a safety or warning device.

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

INSPECTION: Means an 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.

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 its passage through matter.

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 to one-thousandth of a roentgen.

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)).

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 rays 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 changes in materials or equipment.

REM: The special unit of dose equivalent. The dose equivalent in rems is numerically equal to the absorbed dose 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 Texas State University.

TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE): Sum of the deep dose equivalent (for external exposures) and CEDE (for internal exposures).

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 produced 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 extra-nuclear part of the atom as X-Rays.